SILICON CHIP

MARCH 2010
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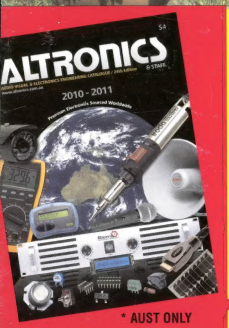

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LOW CAPACITANCE DMM ADAPTOR

FREE! ALTRONICS 2010 CATALOG*

GADGETS FOR THE GREAT OUTDOORS

Bright ideas for your Easter long weekend at Jaycar Electronics

Jaycar Electronics

MARCH 2010

150W Inverter with USB Outlet

SAVE $10

Run mains-powered appliances from your vehicle. This compact (150mm long) inverter plugs into your vehicle's cigarette lighter socket to deliver 230VAC at 150 watts. Also comes with a USB port to charge your iPod®, camera, and other USB devices. *Was $59.95*

$49.95 Cat: MI-5125

UHF CB Twin Pack with Charge Cradle

With 38 channels and a 3km range, these pair of mini UHF CB communications feature electronic volume control, monitor functions and an integrated blue LED torch. Ideal for campers and bushwalkers when a "cooee" just doesn't say enough.

- Dual charge cradle included
- Requires 3 x AAA batteries per unit

Limited stock

$69.95 Cat: DC-1007

12 Volt Camping Shower

Wash away the cares of the day with a warm bucket of water and this excellent camping shower. Simply plugs into your car's cigarette lighter, with long 4.8m power cable included.

Pump, tubing, showerhead, hanging hook and carry bag all included.

$24.95 Cat: YS-2800

Retractable Cigarette Lighter Extension Cord

A handy complement for your 12V chargers and camping appliances. This three metre extension cord retracts into its rugged housing to keep it protected and tangle free.

- 5 amp fuse
- Power indicator

$16.95 Cat: PP-1990

12V Heated Travel Mug

No need to put up with cold coffee ever again. With a thermostat controlled heater, this stainless steel travel mug maintains one of four preset temperature settings - ranging from room temp to very hot.

- Holds 500ml
- Temperature display in C° or F°
- 12V in-car power lead included

$34.95 Cat: GH-1301

Waterproof LED Head Torch

SAVE $30

Waterproof down to 30 metres. This super bright and rugged LED head torch features an adjustable tilting beam, secured with a comfort-fit rubber strap. Ideal for diving, night fishing, boating, caving, etc.

- 8 high intensity LEDs
- 2 lighting options - 4 LEDs or 8 LEDs
- Runs on 4 x AA batteries which are supplied

Limited Stock *Was $59.95*

$29.95 Cat: ST-3074

12V Car Kettle

Plugs into your car's cigarette lighter socket and holds up to 550ml. This travel-friendly kettle makes up to 4 cups of hot beverage or soup.

- 2 cups, strainer and mounting bracket included
- Dimensions: 235(H) x 95(dia)mm

$17.95 Cat: GH-1380

X-Glow Cree LED Rechargeable Torch

No need for batteries. This durable water-resistant torch shines a brilliant 136 lumens and can be recharged either via a mains outlet or your car's cigarette lighter.

- High, low and flashing beam
- Includes car & mains charger
- Includes pouch & carry strap

Limited Stock *Was $99*

$79 Cat: ST-3378

SAVE $20

Full range of torches in-store!

12V Air Pump

Great to use on air beds, beach balls, lifejackets, rafts etc. Powered from your vehicle's 12 volt outlet, its supplied with 3 sized nozzles to suit most inflatables.

$12.95 Cat: GH-1110

Bottle Opener & Knife with LED Torch

SAVE $8

With this gadget you can safely find your way around the campsite at night, and then knock the neck off a couple of coldies. Batteries included.

Limited Stock *Was $11.95*

$3.95 Cat: TH-1901

Gadget & Mobile Phone Solar Charger

$49.95 Cat: MB-3589

Out in the bush and low on battery? Use the sun's free and limitless energy to recharge your mobile phone or iPod®. This charges devices with USB or mini-USB ports, and includes connections for most phones including Nokia, Motorola, Sony Ericsson and Samsung. It can also be recharged from a USB port.

- Dimensions: 94(L) x 60(W) x 25(D)mm

24V Sandwich Jaffle Iron

Why fork out good money for nasty takeaway food? Whether you're out on the road or on the water, cook up a tasty toasted sandwich instead - your stomach will thank you. Non-stick surface for easy cleaning. Measures: 195(L) x 115(W) x 62(H)mm

Limited Stock *Was $39.95*

$19.95 Cat: YS-2806

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Jaycar Electronics

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Publisher's Letter

Councils' e-waste ban will discourage recycling

Over the last six months or more, quite a few municipal councils have announced that they will no longer accept e-waste on street clean-ups. Ultimately, all councils will follow. And if you take defunct equipment to your local council tip, there is now a substantial dumping fee. The stated reason for this is that the councils are concerned with the increasing amount of electronic equipment going to landfill and more to the point, they are concerned with heavy metal pollution.

On the face of it, this is a legitimate concern. Heavy metals dumped in landfill may eventually leach out into the water table and the wider environment. But what heavy metals are we concerned about? Presumably, the list would include mercury (the worst), lead and copper; these being the most used in electronic equipment. Having said that, most of the mercury which ends up in landfill would come from defunct fluorescent lamps, including those used in the back-lighting for LCD monitors and TV sets. But the quantities of conventional and compact fluorescent lamps would far exceed the couple that would be in the LCD monitors which are being dumped.

As for copper, well there is some copper in all electronic equipment, either in the wiring or the printed circuit boards. And lead is a major constituent of the solder used in electronic equipment. So in an ideal world, all these metals would be recycled from this old electronic equipment rather than going to landfill.

The problem is that there is no effective system for collecting all this gear nor presumably, sending it to third-world countries for disassembly and ultimate recycling. While there is some collection and recycling going on, a great deal more needs to be done. In the meantime, the initiative of the councils appears to be misguided. One immediate consequence is that any service organisation now needs to charge for giving a quote, because if the quote is not accepted, the potential customer is likely to leave the defunct unit and the service company will have to pay for dumping it. This means that less equipment is likely to be repaired in the future, adding to an already steep trend.

Nor is the e-waste ban going to stop it being dumped. Instead of putting the gear out for street collection (and possible recycling by electronics enthusiasts), it will be dumped in bushland or smashed up to be put into the domestic garbage collection – so it will still end up in landfill. In fact, I recently spoke to a friend who was about to cut up an old refrigerator with an angle grinder, so he could progressively put it into his garbage bin! I pointed out to him that refrigerators, washing machines etc are not caught in the e-waste ban but it was a very good illustration of what is already happening.

Simply put, councils hate seeing old (and sometimes working) equipment being placed on the street for collection because that must mean that it has been replaced by something newer, larger and better – and we can't have that, can we? I also think that councils have an exaggerated idea of how much heavy metal there is in electronic equipment. For example, I discovered that some council staff believe that each TV and computer CRT monitor contains several kilograms of lead! Well, they do but nearly all of it is locked up in the glass of the picture tube!

In any case, many recycling initiatives are simply too expensive to be worthwhile. This applies to most paper and plastic recycling – it is cheaper to dump it in landfill. Councils should just get over it. We live in a prosperous country which can afford to pay for lots of new electronic equipment. This is a great benefit to us as it improves our productivity and standard of living. And all those imports also raise the standard of living of millions of people in the developing countries. If that means we dump a few million tonnes of old gear each year into landfill, then so be it.

Leo Simpson

Imagine...

a 50MHz, 3-channel full-featured 'scope you can hold in the palm of your hand! Just add a monitor and mouse (no PC needed)!

Imagine no more!

Here's what you get:

- A genuine digital scope that is ready in seconds!
- 50MHz 240MSPS real-time sampling
- 3 channels - 2x 8-bit and 1x 1-bit input
- FFT in dBVrms, dBm (50, 75, 100, 300 600 Ohm termination) with selectable window
- +, –, x and ÷ math functions and memories
- Auto and manual measurements using markers
- USB host - save waveforms as .txt or .csv
- Save screen shots as .bmp
- Easy fast uploads of new firmware revisions
- Full colour 1024 x 768 display
- Perfect with widescreen monitors (but fine with just about any old computer monitor!)
- Very easy operation - virtually the same as an old-fashioned oscilloscope.
- And so much more (see our website for full specs)

Introducing ScreenScope - the new type of scope you are going to love to take anywhere and use anywhere. All you need is a mouse and virtually any computer monitor. You <u>don't</u> need a PC and it's fun to use! And just look at the low, low price:

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Wind generators & desalination plants

Relevant to your concern about wind generators and desalination plants – I have recently returned from a Melbourne to Mt Gambier bus trip and I was amazed at the number of these things. There aren't just a few – there must be hundreds and they go for kilometres in this section of southern Victoria alone.

Now I don't know how much power a desalination plant actually needs (I suppose it depends on the size of the plant) but my point is that these turbines are driven by the "Roaring Forties" – winds that blow from west to east along Bass Strait and apparently never stop. If you doubt this, check out **www.abc.net.au/science/articles/2007/09/20/2038604.htm**. So I think that in Victoria, at least, we should be covered.

Graham Hunt,
Mt. Martha, Vic.

Comment: there is no place on Earth where the wind blows all the time. Wind power always requires base-load power stations as back-up.

Power problems in Perth

There was an interesting news report on ABC radio, Monday 18th of January. It seems that, during the hot weather in Perth at the time, there had been widespread blackouts and the electricity authority had blamed this on people using air-conditioners. But, it was added, the problem was exacerbated by people using plasma TVs!

And to think that the Federal government, in its grand wisdom, had banned incandescent light bulbs to reduce energy consumption! There's is a rather grim irony there somewhere. And since light bulbs, incandescent or whatever, are only used at night while plasma TVs are used all the time, it does seem that we have gone backwards!

Paul Carson,
Westmead, NSW.

Secret world of oscilloscope probes a revelation

My congratulations to Doug Ford for a marvellous and illuminating article on oscilloscope probes in the October 2009 issue. My long-time puzzlement over the reason for distributed resistance in the cable is cured. Well done.

John Macleod,
Gymea, NSW.

Spelling mistakes occur easily

I have just received the February 2010 issue and thought I should send you a brief note, in order for your magazine to retain its high standard. In your article about Automotive On-Board Diagnostics, it seems whoever wrote the introductory paragraph made the (not unusual) mistake of thinking that the past tense of "to lead" is spelled "lead" and pronounced as in the metal, whereas in fact the past tense of "to lead" is "led".

A minor issue perhaps, but worth pointing out.

Alex Danilov,
Naremburn, NSW.

Comment: while we find it most annoying when mistakes are pointed out, we appreciate that readers make the effort to do so. It keeps us on our toes and as you say, helps maintain the standard.

SILICON CHIP should not encourage global warming sceptics

The cover on the January 2010 issue caught my eye and so I bought a copy. What a shock! Nuclear power stations for desalination, "bring back incandescent lamps", global warming deniers – good grief! All in a technical magazine.

Concerning nuclear power to run desalination, the point seems to be completely missing that running seawater through a reverse osmosis (RO) desalination plant is a stupid and wasteful stopgap. The environmental damage caused by discharging secondary treated waste water (nutrient

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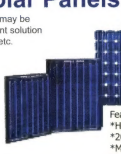
Monocrystalline solar panels are designed for long life (up to 20 years) and high efficiency output. These units may be ganged into arrays for applications where high power output is required, eg. for large battery banks. An excellent solution for remote or mobile power applications, electric fence battery banks, inverter systems, RV's, caravans, boats etc. All aluminium frames and tempered glass panels allow installation in the most demanding environments. To prevent moisture ingress, the solar cell modules are laminated between sheets of high transmissivity 3mm tempered glass, tedlarpolyester-tedlar (TPT) material and sheets of ethylene vinyl acetate (EVA).

Stock#:	Max Power	Rated Voltage	Short Cct Curr.	Open Cct.	Dimensions LxWxH	Price
#36994	**10W**	12.0V	**0.56A**	22.0V	396 x 289 x 23	**$49.00**
#36995	**20W**	12.0V	**1.17A**	21.6V	645 x 295 x 25	**$98.00**
#36996	**40W**	12.0V	**2.28A**	21V	645 x 545 x 23	**$195.00**
#36997	**80W**	12.0V	**4.55A**	21.8V	1210 x 540 x 35	**$358.00**
#37873	**120W**	12.0V	**6.82A**	21.8V	1500 x 660 x 35	**$530.00**
#37970	**175W**	24.0V	**4.87A**	45.1V	1508 x 808 x 35	**$740.00**



Features:
*Heavy Duty Metal Frame
*20 Year Limited Warranty
*Monocrystalline Silicone
*3.2mm Tampered Glass

Waterproof Solar Power "PV" Connectors

IP67 rated for maximum environmental protection, these photovoltaic (PV) system connectors are ideally suited to harsh installations such as solar panel arrays and other permanent outdoor applications. Both panel mounting and in-line connectors are available to suit a wide range of system applications

Specifications:
Rated voltage: 1000VDC
Rated current: 30A at 70°C, 25A at 85°C
Contact resistance: <5 milliohms
Temperature range: -40 - 90°C
TUV certification: 2 PfG 1161/01.06

4mm Female In line Connector

$5.70
#38164

4mm Female Panel Mount Connector

$5.70
#38165

4mm Male In Line Connector

$5.70
#38166

4mm Male Panel Mou Connector

$5.70
#38167

Solar Panel Mounting Hardware

There is a 2m size available of which you can join them together to extend as far as you need to. Then you'll need some brackets to clamp your panels onto the rails. After that, you'll need L-brackets to mount the rails to the roof. These come in packets of two. These come in two different sizes and two different types - 28mm for 10, 20, 40 and 80 watt panels, and 35mm for 120 and 175 watt panels; Z-type for clamping the end of each panel and T-type for clamping between two panels

2m Extruded Solar Panel Mounting Rail

$52.80
#38157

80mm Extruded Rail Joiner Bracket

$17.20
#38158

Rail Mounting Bracket L-Type (Pk-2)

$20.50
#38159

Mounting Bracket Z-Type (Pk-4)

$47.20
28mm #38160
35mm #38161

Mounting Bracket T-Type (Pk-2)

$29.50
28mm #38162
35mm #38163

Solar Charger Regulator

Specifications:
Battery Voltage: 12V
Open circuit Voltage: 12V
Continous charge: 20A
Maximum charge current: 25A
Maximum load current: 25A
Operation Current: 30mA
Voltage across terminals (PV to Battery): 0.8V
Voltage across terminals (Battery to Load): 0.4V
Recommended wire size :#12 AWG
Weight: 0.47kg
Dimensions (WxHxD): 150 x 85 x 45mm
Operating Ambient Temperature: -10 to 50°C

#36998	**20A**	12V	**$99.50**
#38179	**30A**	12V	**$127.00**
#38238	**20A**	24V	**$127.00**

Pure Sine Wave Inverters

Input: 12VDC
Output: 100-120V/220-240VAC
Pure sine wave efficiency: >90%
Full load efficiency: >85%
Low I/P protect: 10±0.5V /20±0.5V
*Overloading protection
*Short circuit protection
*Auto restart function

Stock#	Watts	Price
37964	**1500W**	**$480.00**
37965	**2000W**	**$685.00**

Modified Sine Wave Inverters

Input Voltage: 10-15VDC
Standby Input Current: 0.2A
Output: 240V ~ 50Hz
Manufacturer: PowerBright
Overload Protection

Stock#	Watts	Price
38118	**400W**	**$69.50**
38119	**1100W**	**$145.00**
37938	**3500W**	**$483.00**

12VDC Solar Battery Trickle Charger

Lead acid cells will self-discharge, even when completely disconnected, if they are not re-charged regularly, eg. when a car is not driven for long periods or on a boat which is used infrequently. Includes suction cups for mounting to inside car windows, alligator clips and cigarette lighter adaptor lead.

$25.00
#36450

5W 12V Solar Battery Charger

Sturdy, all-weather construction with anodised aluminium frame and tempered glass panel. In ideal conditions, produces up to 400mA charge current which would be sufficient to charge and maintain a 12V lead-acid battery
Dimensions 465x 320x 25mm

$49.00
#36653

4xAA Solar Battery Charger

The solar panel in the lid will charge up to 4 x AA NiCads in a fairly short time. It is ideal for yachts, campers or anywhere 240V is not available. It is NO DEARER than an ORDINARY NiCad charger but takes about the same time to charge in reasonable sunlight
Size: 85(W) x 30(H) x 96(D)mm

$19.20
#38153

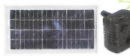
10 LED High Brightness Solar Powered Torch

Featuring 10 high brightness white LEDs and internal rechargeable batteries that are charged by the solar panel on the handle, this aluminium torch is ideal for anyone who loves the outdoors or works at night. Leave it basking in the sun during the day for a light filled night.
Dimensions:
Solar panel measures: 120(L) x 28(W)mm
Torch: 210mm long

#38152
$22.70

2.4W Solar Powered Water Pump

Operating voltage: 12V
Power consumption: 2.4W
Flow rate: 200 litres/hour
Outlet size: 8mm
Cable length: 2m
Dimensions:
Solar panel: 308(L) x 166(W) x 25(H)mm
Pump assembly: 42(L) x 39(W) x 28(H)mm

$77.50

#38130

Solar Powered LED Spotlight with PIR

Specifications:
* Lamp measures: 145(W) x 95(H) x 75(D(mm
* PIR sensor Measures: 145(W) x 60(H) x 120(D)mm
* Sensor range: 15 metres x 110°
* Battery box measures:165(W) x 90(H) x 150(D)mm
* Solar panel measures: 350(W) x 185(H) x 30(D)mm
* Lead length approx three metres
#38239

$77.00

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Mailbag: continued

DAB+ sampling rates are too low

I am not a "Digital Sceptic"; maybe more of an audiophile or hifi snob. Digital audio from a well recorded CD can produce beautiful sound through a high-quality stereo system. But I am somewhat baffled by the phrase "Listen to that Beautiful Digital Sound" sometimes used to advertise Digital Radio because unfortunately, the audio quality from our Digital Radio Broadcasting system is not necessarily beautiful. I have done extensive listening to DAB, (Eureka-147) in both Denmark and the UK, and found that DAB audio quality is marginally better than AM but not even close to FM.

The main reasons, I believe, are the bit rates of 128kbits/s or lower being used by the majority of stations. Statements by a leading BBC engineer claim that a bit rate of 256kbits/s is necessary for serious music, while 192kbits/s or even as low as 160kbits/s may sometimes be adequate for some types of pop music.

Many complaints from listeners, particularly in the UK, tend to support the BBC statements. But claims by certain officials that the DAB+ (AAC+) system now used in Australia, is twice as good as the obsolete DAB, and therefore allows us to have twice as many radio stations, are utterly uninformed and irresponsible nonsense.

DAB+ is better than DAB but not twice as good. 128kbit/s DAB+ is probably equivalent to 192kbits/s in DAB and is perfectly satisfactory for the majority of commercial radio stations. The 64kbits/s DAB+ used by most of the Australian commercial stations, equivalent to 96kbits/s in DAB, is simply not good enough and nothing to be proud of.

80kbit/s DAB+, as used by ABC Classical, roughly equivalent to 128kbits/s DAB, is something they should be ashamed of, since the DAB+ audio quality is notably inferior to ABC Classical FM. ABC Classical should broadcast at 160kbits/s which will provide the audio quality deemed necessary by the BBC.

I recently purchased a Sangean WFT-1D FM DAB+ hifi component tuner in order to back my arguments. It is a very nice piece of gear. For sound quality comparisons, I listened to some piano pieces while switching between a hifi FM tuner and the Sangean DAB+ tuner.

The natural string decay nearly disappears on DAB+. Presenters' voices sound about the same on both but audience applause is vastly different between FM and DAB+. High frequencies sound natural on FM. By contrast, they sound squashed and the highest highs are missing on DAB+ but I believe that is how audio compression works.

Australia had a chance of being the world leader in Digital Audio Broadcasting by being the first country to adopt and use the excellent DAB+ technology. Unfortunately, it looks like corporate greed by the owners of the commercial transmission systems, and political wrangling between government-controlled broadcasters and their internal departments, has blown any chance of DAB+ audio quality in Australia being a benchmark for other countries to follow.

Poul Kirk,
South Guildford, WA.

discharge, depriving the environment of water for human needs) are doubled by adopting seawater RO (wasteful use of energy, brine discharge). Many overseas metropolises have long since switched to recycling waste water.

Water utilities know that this is the only answer but their political masters are terrified that the opposition will point score to the high heavens on this one and be joined in by the press who also have short term profit motives. Too bad we don't have a single politician or journalist who would know a scientific fact if he/she fell over one. We need politicians and journalists who have some technical nous and have the guts/statesmanship to stand

up for what is in the best interests of this country rather than short term interest.

Sadly, most journalists have no idea of what science is about, having been brought up in humanities-focussed training. On purely economic grounds, the cost of running seawater through RO is prohibitive compared to RO for treating secondary waste water. Heavy industry in WA has been supplied by recycled waste water for years now. Users are happy to pay a premium for the privilege, because the purity of the supply removes the alternative expense of having to clean up best-quality reticulated scheme water to industry standard.

The waste water RO supply has a solids content of about 30 ppm compared to anything up to 700 ppm for reticulated mains supply water. In any event, every Tom, Dick and Harriet seems to be running around clutching bottled water these days, so what's the problem? In WA, the catch-phrase used by the press whenever the issue is raised is "recycled sewage" – which is a logically incorrect term and which terrifies the uneducated and sends politicians diving for cover (water is recycled, not sewage).

With respect to nuclear power for electricity, what we need is a scientific/technical evaluation, not an opportunity for the fools that run newspapers and those we put into parliament to pretend that they espouse green values.

Some countries have done exceedingly badly and some have done remarkably well with nuclear energy. In this respect, I understand that for the Swedes, nuclear-generated electricity is not an issue to be concerned about. We desperately need a value-free assessment of all power/water issues before it is just too late.

With respect to incandescent lamps, since the first fluorescent lamps appeared on the market they have progressively replaced incandescents in my home. I had to wait for the price to drop before total replacement. Consequently, my electricity bill has dropped by a significant amount. The energy savings to the country as a whole have to be huge, multiplying out my household savings by the total households in the country.

Finally, on global warming, it is a poor reflection on SILICON CHIP to give space to global warming sceptics. A good example can be found in *New Scientist* weekly, that has followed global warming issues that were known to be contradictory to other evidence and has provided a value-free discussion. *New Scientist* has rightly ignored the nutter arguments completely as there are no further grounds left for discussion. Global warming denial is like religion – espoused by those who believe in what they want to believe in, not what the evidence would compel them to believe in.

Rob Holmes,
Lesmurdie, WA.

Comment: in 2006, the then Federal Government commissioned a report on nuclear power by Dr Ziggy Switkowski (chairman of the Australian Nuclear Science & Technology Organisation).

Compact fluorescents are good

The recent comments about compact fluorescent lamps and their disadvantages seems dismaying. My experience has been completely to the contrary.

I run a 2kW "micro" hydro plant, producing 240VAC at 50Hz, the frequency held steady by a governor to ±0.2Hz. For garden and outbuilding lighting during darkness, I have a timer set for 5.00 PM. An LDR/relay combination then completes the switch-on at dusk, ie, at 5.30 PM during winter and as late as 8.45 PM in summer.

To allow people to sleep, the timer cuts all lighting at 10.30 PM.

At a recent family celebration, I had 18 CFLs (of the so-called 20W variety), all switched on at once. There were no blown fuses, timer failures or contact breaker (CB) drop outs, with the plant ammeter showing a paltry 2A load. I find a great advantage of CFLs is the low cable loss per light watt compared to incandescent mini heaters, with no damage and odour to lamp holders.

I cannot see LEDs competing cost-wise (wonderful as they are) when we have to pay $1.60 for a 4W Superbright, when we can use a 90-100W CFL for $4.50. However, it does seem draconian to have to pay that for occasional lighting when $1.00 used to do the job.

The system outlined above has run for four years now, with no switching failures. During the day, the plant runs a clothes dryer (cabinet type). During low water, the LDR is used to stop and start the plant.

Tony Beard,
Taupo, NZ.

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Video projectors are at risk from blackouts

Some months ago, I set my video projector going and got a message stating that the lamp had reached the end of its useful life and that it should be replaced. This seemed strange because the lamp had only done about half the time stated by the manufacturer.

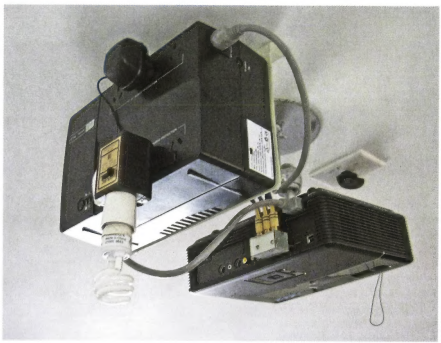
Another thing was that the projector was getting very noisy. It was not the fans because I had checked them out. Anyway instead of buying a new lamp ($400 to $500) I decided to buy a new projector with a higher resolution. The one I wanted was out of stock everywhere so I had to wait a few weeks for it to arrive.

While waiting, I set the whole place up for high-definition TV. When it did arrive we mounted it up and were able to enjoy movies on the big screen again. The only problem was that I had a suspicion that the problems with the old projector were caused by instant shut-downs.

As you know, you are supposed to turn the projector off with the remote control and leave the power connected for the few minutes that it takes it to go through the shut-down cycle. That's OK but what do you do when the power goes off?

As a result, I decided to connect the new projector to an uninterruptible power supply (UPS). As it happened, Dick Smith had a 700VA one on special, so I bought it and ran a series of tests using the old projector and it worked perfectly.

That left the problem of where to put the UPS. In the end I mounted it on the ceiling just behind the projector, as you can see in the accompanying photo. After I had mounted the UPS I realised that the power outlets



at the top work directly off the mains while the bottom ones are backed up by the battery. I mounted a BC socket on an empty plugpack case and fitted a miniature relay (12V DC coil, 230V 10A contacts) inside it, using the normally-closed contacts to switch a 9W compact fluorescent. Into the top socket I plugged a 9V DC plugpack to supply the 12V for the relay coil.

The biggest disadvantage is that the relay is energised all the time but in our case the power to the UPS is only on from dusk until we go to bed. The advantages are that the power comes on to the top sockets straight away and on to the bottom sockets after the button on the UPS has been pressed, meaning that there is no power on the contacts when they operate. Also, the filter capacitor in the 9V plugpack causes a delay of a couple of seconds so that the lamp load is not dumped on to the UPS at the same instant as the projector.

Just recently, we had another blackout when we were using the new projector/UPS set-up The screen suddenly showed the video projector's home and the 9W CFL came on. For a moment or two I was at a loss as to what was going on. Then I realised what was happening. All I had to do was pick up the remote for the projector and turn it off. After it had shut down, the lamp kept the place lit, until the power came back on. I think that the UPS has already paid for itself.

Ron Groves,
Coloola Cove, Qld.

Comment: interesting story Ron, particularly as it highlights the hazard to a projector when a blackout occurs. Your solution is also good.

In his very comprehensive report, Dr Switkowski pointed out that nuclear power will never be competitive with coal-fired power stations unless there is a carbon tax. While we don't support a carbon tax (see Publisher's Letter, February 2007), the thrust of that report is still valid. Politicians have yet to do anything about it.

As far as compact fluorescent lamps are concerned, the changeover from incandescent lamps will have very little effect on most domestic energy bills since lighting is not the major power consumer in most homes. In most homes, heating, refrigeration and air-conditioning are the major power uses.

Finally, applying emotive labels to sceptics shows an inability to acknowledge that not all "climate science" is "correct", "settled" or even scientifically based. It is now quite clear that dramatic predictions about global

Solar power needs base-load power stations as well

Your Publisher's Letter on the topic of wind power in the January 2010 issue certainly makes sense. My own observations of wind speed suggest that the wind is either strong or dead calm and not too much in between.

However, your letter begs the question: in what circumstances are wind generators useful? I have seen them at Albany and Esperance, WA and the biggest field I have ever seen was on St. Vincent's Gulf. Maybe, at a place like Esperance, there are standby diesel generators with battery backup to smooth the change-over? We used to say: "using a steam hammer to crack a nut!"

Perhaps solar power, obviously diurnal, is just as bad as wind, although Germany seems to have gone solar in a big way. But there is the claim for solar that on a hot day, when the air-conditioning load increases, the solar output should be at maximum. Does this really work?

I know you have advocated nuclear power. I don't quite understand why there should be so much fuss about storing nuclear waste. Storage facilities will be monitored and what is stored will be well documented. It would be amazing if in 200 years, say, there will not be new technology which would solve the whole problem.

John Waller,
Plainfield, CT, USA.

Comment: both Spain and Germany have invested heavily in solar power. Spain is also developing the concept of solar storage so that thermal power stations can run at night, effectively still powered by the Sun. The solar storage is based on molten salts, such as potassium nitrate, stored in large insulated tanks. More on the concept can be found at ***http://media.beyondzeroemissions.org/solar_thermal_basics_fact_sheet.pdf***

On the face of it, this could be more useful in Australia than wind farms.

temperature rise, sea-level change, glaciers melting, loss of coral reefs and so on, could be far off the mark.

In so far as climate predictions affect energy generation and usage, it is appropriate for SILICON CHIP *to comment and for readers to contribute to the debate.*

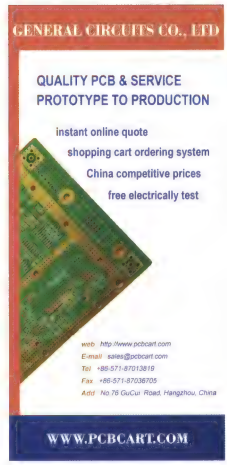
Smart electronic equipment can be dumb

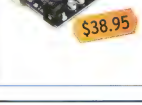
This letter is about the mindset of operators of machinery. When something stops working properly, an operator will switch out from their symbiotic mental relationship with the gear and into a more antagonistic mode which can lead to some poor decision making.

I have steadily built up a negative view of some "smart" equipment electronics, which though using a CPU that could comfortably run Flight Simulator, when things go wrong do not tell the operator anything helpful. Why don't software people build in comforting messages, out-of-bounds sanity checks and plain English warnings into this stuff?

I work in agribusiness. Over dry periods, we have to feed out large quantities of hay. We have big feed machines that you can throw loose silage into (like grass clippings) or large round or square bales of hay, up to about 10 tonnes at a time.

These machines have multiple





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hydraulic motors to unload the hay, including moving-floor motors, side delivery motors and a dispensing motor. The operator jiggles a joystick to work various motors to deliver feed from the machine onto a trail on the ground, while driving along and avoiding fences, gates, livestock and parked vehicles.

The job is all done using just two hydraulic circuits, each of which comprise a pair of hoses from the machine that quick-connect onto the back of the tractor. There are levers in the tractor to control oil flow either way around the circuits. The levers will latch on, so oil can continually flow without the operator hanging onto them. On the feed machine there are electric solenoids that control which motors the oil is routed to.

There are two common sizes of these valves; the smaller one fitted to 10mm hydraulics draws about 2.5A while the bigger one on 15mm hydraulics draws 4.2A. A cable of about 10 cores connects between the control unit in tractor and the machine to actuate the solenoids and to power the weighing scales. All this is simple enough to use and to service.

Unlike other workplaces there's very much a fix-it-yourself attitude in agriculture but this is not necessarily a good thing. We've had several instances where these feeders have stopped working and the operator has stripped out the joystick, the connectors onto the solenoids and almost anything else they can get their hands onto with a screwdriver and shifter. We're left to put it all back together and find what really went wrong.

The most common problem arises because the tractor is frequently disconnected from the machine because the tractor loads the machine using its front-end-loader. The operator has to unplug the hydraulics and the control cable each time and reconnect to unload the machine. Operators don't like doing that much, because it's usually hot, dusty and dirty at the back of the tractor, compared to being in the air-conditioned cab. Hence the job is usually rushed.

Hydraulics are rather like electrical circuits; the oil has to come out of the circuit in order for more to go in. You will recall there are two hydraulic circuits. If you swap over the plugs of one pair, the feeder will simply run backwards – easily fixed by setting the control lever the other way. If you cross pairs though, you can't get anything to happen (apart from a rather stressed noise in the guts of the tractor as it blows off oil at about 20Mpa). If you don't quite get a plug pushed in far enough you also can't make oil flow.

Another common problem is that the fuse blows in the tractor. We did have a poor type of connector that you could blow the fuse during a normal re-connect operation but now it's generally just one loose wire causing the fault. Whatever causes the fault, in the mind of the operator it's always the most complicated bit that's gone wrong, so it needs to be stripped down.

After much thought and chewing the ends off grass stalks (as we do when thinking), I made up an indicator light for each machine. I wound 10 turns of 1.2 mm enamelled wire in two layers. I mounted a reed switch inside this coil and connected this reed switch to a LED. The coil is in-circuit with the centre lead of the joystick. So every time current flows as a result of joystick action powering a solenoid, the LED comes on.

It's beautiful! The operators get the idea straight away, they can see which circuit is not working properly and we have not had a trashed installation in the last few years.

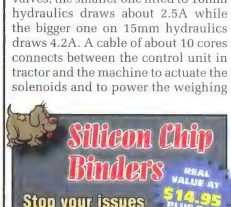
Now, you if you guys writing controller software could come up with some similar concepts, it would be pretty helpful . . .

Kevin Shackleton,
Dandaragan, WA.

Electronic equipment software can be silly

First let me congratulate you on your magazine. I have been a subscriber for many years and have a copy of every issue and I still eagerly wait for every new issue. I know you work hard and it is much appreciated. SILICON CHIP is a well-written and well-respected magazine and I noticed the other day an article in one of the (few left) overseas electronics magazines reproducing one of your articles as part of a deal they have with you no doubt.

Increasingly, I am finding that the software and user interface of a particular piece of equipment is more important than almost anything else.



When you go into an electrical retailer to buy a new TV, home theatre system, washing machine, microwave oven or whatever, the focus is always on what it looks like, the picture, the audio quality etc.

The software, user interface and even more importantly the remote control is never fully investigated. In particular, the remote control is often not easily available to try as they are all locked away in case someone walks off with them.

So you go and buy your new whiz-bang piece of hardware and take it home and set it up and then find that it doesn't work exactly how you expected it would. You think to yourself, what were they thinking when they wrote the software? Or in the case of mobile phones these days, how big do they think the average adult male's finger is? Have you seen how small the buttons are on phones these days?

When you get your new phone you find that some of the useful software that was in the old model isn't there any more, like the timed meeting option some of the Nokias had – when you went into a meeting, you could set it to silent for what ever the duration of the meeting was and it would automatically come off silent after the time had elapsed. I often turn my mobile off and forget to turn it back on after meetings.

What prompted me to write to you is that I have just purchased a Belva digital TV. It has just been released and it had a few bugs in the software. You might want to do a review of this TV as it is quite impressive for its size, price and low power. Have a look here if you are interested in it: **http://www.hitv.com.au/products/list.jsp?category=11**

The TV is impressive but the software isn't. I purchased the TV specifically to use when travelling. My wife is deaf and uses the subtitle facilities that come with digital TV.

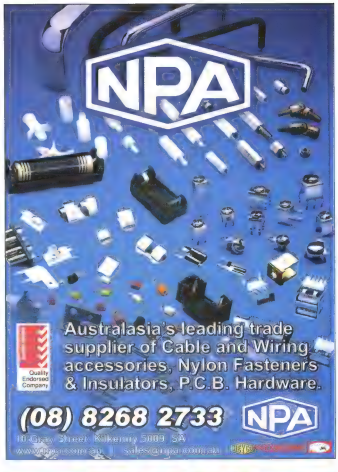
There was a problem with the way the subtitles are turned on and what happens when the TV is turned off. To turn the subtitles on you must turn them on for each individual channel you want them on. Once this is done, you can change channels and get the subtitles on all channels that currently have them. If you turn the TV off and then back on, you have to go through the process again, that is select each channel in turn and turn the subtitles on. It is most annoying and not logical.

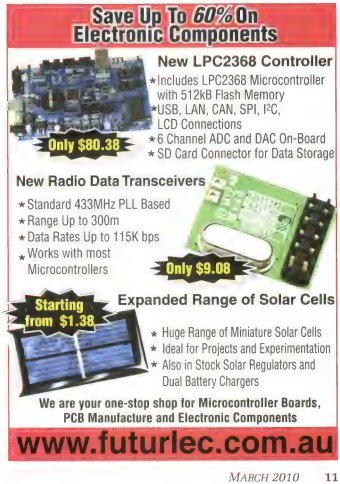
Fortunately, after I complained about this, the manufacturer got back to me within about two weeks and sent me a software update which I promptly loaded. This has now cured the problem.

I still haven't gotten over the third CD player I bought. I had a owned a JVC and then a Sony, so when it came time to replace it I found I couldn't buy a simple single disc CD player from JB Hi-Fi but they had a little Sony DVD/CD player for around $100 and I thought, what a bargain!

I got it home and set it up and put a CD in and found out how slow it was to figure out what type of disc I had put in it. If only it had a little setting or switch where I could tell it. This is an example of where a "better product" isn't. I basically gave up on playing CDs on it but recently bought a NAD CD player for about $400 just so I can play CDs like the old days.

John Louttit,
Stafford. Qld. SC





MACBOOK

Computer companies release their latest models with much fanfare and we all go 'ho-hum', as the look and feel of a new computer soon vapourises when we discover bugs, plus a host of software and drivers won't work without expensive upgrades. This time Apple should have bought out the brass band and fireworks!

"Hands-on" review by Kevin Poulter

It's amazing to operate the new MacBook and find everything works, with only minor exceptions. Adding to its functionality, the new high brightness LED-lit screen is simply sensational. Everything that Apple promised five years ago – but users soon found to be limited, or even buggy – has come to fruition.

The test of Apple's new MacBook was not without some reservations. A quick demonstration in a busy store left the impression that the new MacBook screen is too widescreen in format, with a slightly clunky keyboard and the intelligent multipurpose trackpad is a buggy gimmick. . . especially as the salesperson couldn't enlarge images with two fingers, as promoted.

Wow – it works

How wrong this preconception was! The widescreen format is amazing for viewing HD video, plus the best for word processing or graphic production.

When using software (Apple calls it 'applications') the wide screen has room for tools on the side, leaving much more 'acreage' for viewing the document being created.

The screen is beautiful, with the highest contrast, intensity, colour saturation and clarity; especially suited for those who don't have 20/20 vision. Heck, any brighter and you'd need sunglasses! Sure, the brightness and saturation are adjustable, but few users will, as an excessively bright, colourful screen looks terrific.

The MacBook's keyboard soon proved to be most suited to wordsmiths, with the biggest surprise – how easily fingers glide over the new glass trackpad, instead of binding.

Innovation brings its rewards

It's likely the MacBook and its software works so well as Apple is highly cashed-up with the proceeds of selling innovations, empowering a much higher R&D spend.

Even before the new tablet computer was launched, Apple computers reached number two in the USA. Apple is now a US$50+ billion company. In the fourth quarter of 2009, Apple sold 21 million iPods, 8.7 million iPhones and 3.36 million Macs.

Click and hold on any folder like the Downloads folder, to open it to display the contents for selection.

Click and hold on the applications folder in the dock and all Applications and Utilities appear for selection.

2010 APPLE'S BEST SECRET?

First impressions are the cool, elegant design, then detail like the built-in microphone and camera, plus the power adaptor plug/socket, an innovative 'magnetic lock connection' (MagSafe).

Until now, regular stressing of the power adaptor lead risked breaking the internal wires. Then the whole unit had to be discarded – about the same time the power adaptor was no longer available.

A powerful magnetic solution

Apple's 'MagSafe' solution is a dream to use. The powerful magnet connects the plug from some distance out, without a glance, in any light. Simply hold it in approximately the right area, and wow - the magnet grabs and connects perfectly every time.

Further, the small 5-pin connector works either way around, with the lead facing or away from you. Once connected, if there's a sudden strong tug on the lead, the MacBook won't fly off the lap or stress the internal wires – rather the plug will break away.

As a bonus, the LED on the connector changes from amber to green when charged.

The power adaptor

The five contacts are tiny, almost microscopic, yet the power adapter is capable of delivering at least 3.7A.

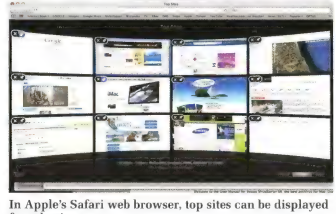
It's likely that connecting with the mains power on will eventually burn these contacts. Further – after the user runs down the battery, when connecting to recharge, the adaptor becomes excessively hot.

Keep your cool

A few simple procedures will help the power adaptor last the life of the computer. The ideal is to run the MacBook on the power adaptor whenever practicable. When the battery is depleted, before connecting the power adaptor, turn the mains off and close the computer lid. Otherwise, the charger is supplying about 3.7A at 16.5V for charging – and running the computer.

This simple procedure changes the sealed charger from becoming unacceptably hot, to comfortably cool. After

You can swish through a display of viewing history, with a stroke of the trackpad.



In Apple's Safari web browser, top sites can be displayed for selection.

The power cord is held in place magnetically, so if someone should trip over the cord, it disconnects and the MacBook stays put.

about ten minutes, even though not fully charged, it's OK to resume using the computer.

The Dock

A collection of icons is displayed at the bottom of the screen or can be moved to the left or right side, to provide quick access to applications, documents and folders.

The contents of folders in the Dock are called 'stacks', displayed by a click and hold on the folder. The most useful of many features of the Dock is quick access to any open or closed applications.

Also, when many windows are open and covering the desktop, the Dock will show any application's open documents. Simply scroll along the dock's icons, click and hold on the application and voila! the desktop is suddenly uncluttered, only displaying the icons for documents open in the selected application.

Wired for sound

The inbuilt microphone works so well, on purchasing an expensive third-party mic-headset combination for Skype, it was annoying to find the built-in microphone and speakers worked better!

The sound is good, considering the tiny reproducers. There's no evidence of the speakers' location, however they appear to be behind the almost hidden air-vents. Speaking of air-vents, the MacBook remains cool enough to use on your lap for hours, with a fan so silent, it's impossible to hear.

Earlier 'piano-finish' iBooks soon became hot and were at risk of sliding off your knees but the new MacBook has a rubberised base, to both insulate you from heat and as an anti-slip base.

Power to go

The Mac's built-in lithium-polymer battery lasts up to seven hours on a single charge, apparently a 'best-case' rating. However the freedom to work for five hours or more with no recharge is awesome.

Thanks to its advanced battery chemistry and charging technology, the MacBook battery can be recharged up to 1000 times, lasting nearly three times the lifespan of other notebook batteries. I break the rules and leave the power pack charging all the time, with no major disadvantages.

You are not alone

When the MacBook is launched for the first time, a setup assistant appears, asking a few simple questions, to get the new Mac started in minutes.

Already armed with some information the MacBook needed, like the ISP connections and with Apple's Airport Wireless on, it was amazing how few windows of questions opened before it was all systems go!

Starting anew

One of the setup questions came with an offer – connect an Ethernet cable now to transfer all the data in your old computer. No thank you! Changing to a new computer is the perfect opportunity to start afresh, without the 'baggage' that is clogging the old computer.

This strategy made the transition incredibly easy and worked perfectly.

Knowing that upgrades to some expensive software like Photoshop would dent the pocket by over $1,000, and that too much software eventually slows a computer, I kept the old computer for this work, also saving considerable effort getting them to run.

Not just a trackpad

MacBook's Trackpad not only recognises the number of fingers you are placing on it for different functions, it also knows the direction they are moving – like the iPhone.

This remarkable technology is best demonstrated with images, so we have shown these below. Functions include rotate, scroll and much more.

One of the coolest is enlarge. When viewing an image or some windows, they can be enlarged by moving two fingers apart or as I discovered, by touching the trackpad with two hands and moving the fingers apart. This is brilliant for a closer look at some images, especially if your vision is not 20/20.

Now my desktop is permanently enlarged for super-easy viewing at any distance. Sometimes the advanced Trackpad functions are a bit sluggish or quite resistive though. Hopefully a software upgrade soon will improve their reliability.

Innovation for everyone

Built-in VoiceOver screen-reading technology enables people who are blind or have low vision to control their computer using key commands or gestures on a Multi-Touch trackpad.

Mac OS X also offers out-of-the-box support for over 40 Braille displays. In addition, preferences settings help vision-impaired, from highly enlarged text to realistically reading web or

The trackpad knows if you have one, two or more fingers touching it, plus the direction of travel and acts accordingly...

typed pages – very close to a 'real' person narrating.

The voice in VoiceOver called Alex, utilises advanced Apple technologies to deliver natural intonation in English even at extraordinarily fast speaking rates.

While most text-to-speech (TTS) systems analyse and synthesise text one sentence at a time, Mac OS X analyses a full paragraph to decipher the context more accurately. In addition, Alex more closely matches the nuances of human speech, to more easily understand longer text in books, articles, and news stories.

Power of UNIX, Simplicity of the Mac

Mac OS X is renowned for its simplicity, reliability, and ease of use.

So when it came to designing Snow Leopard, Apple engineers were briefed with a goal: to make a great thing even better. They searched for areas to refine, further simplify, and speed up. In many cases, they elevated great to amazing.

Recently the performance of graphics processing units (GPUs) has grown exponentially, measured in gigaflops. Today's fastest GPUs are capable of over one teraflop, as much as the room-size ASCI RED supercomputer of just 12 years ago.

The advanced technologies in the operating system take full advantage of the 64-bit, multi-core processors and GPUs to deliver the greatest possible performance.

With a fast 2.26GHz Intel Core 2 Duo processor, MacBook breezes through everyday tasks such as emailing, web browsing, and working with documents, spreadsheets and presentations. Better still, MacBook comes standard with 2GB of memory (with support for up to 4GB), so you can run multiple applications smoothly and efficiently.

Software – applications are the key

Apple's innovation and quality are excellent but PCs have led in one area – price. Until now.

When you consider the quality and ease of use, MacBook is the best choice – but add all the pre-loaded software into the equation, then price is no longer a barrier to a fun, easy to use computer.

The MacBooks sell for a similar price, $1,299, almost everywhere. Even though legally they cannot enforce it,

Technical Specifications:

Processor:	2.26GHz Intel Core 2 Duo processor with 3MB on-chip shared L2 cache running 1:1 with processor speed, 1066MHz frontside bus
Memory:	2GB (two 1GB SO-DIMMs) of 1066MHz DDR3 SDRAM; two SO-DIMM slots support up to 4GB
Communications:	Built-in AirPort Extreme Wi-Fi wireless networking, Bluetooth 2.1 + EDR (Enhanced Data Rate) wireless, 10/100/1000BASE-T Gigabit Ethernet.
Screen:	13.3-inch (diagonal) LED-backlit glossy widescreen display with millions of colours
Graphics/video support:	NVIDIA GeForce 9400M graphics processor with 256MB of DDR3 SDRAM shared with main memory. Extended desktop and video mirroring: Simultaneously supports full native resolution on the built-in display and up to 2560 by 1600 pixels on an external display, both at millions of colours Built-in iSight camera
Video output options:	DVI output using Mini DisplayPort to DVI Adapter VGA output using Mini DisplayPort to VGA Adapter Dual-link DVI output using Mini DisplayPort to Dual-Link DVI Adapter supports 30-inch Apple Cinema HD Display (optional)
Input:	Multi-Touch trackpad for precise cursor control; supports two-finger scrolling, pinch, rotate, swipe, three-finger swipe, four-finger swipe, tap, double-tap and drag capabilities
Audio:	Built-in stereo speakers Built-in omnidirectional microphone
Audio in/out:	Combined optical digital output/headphone out (user-selectable analog audio line in)
Ports:	Gigabit Ethernet port Mini DisplayPort Two USB 2.0 ports (up to 480 Mbps) Kensington lock slot
Storage:	250GB 5400RPM Serial ATA hard disk drive; optional 320GB or 500GB 5400-rpm drive 8x slot-loading SuperDrive (DVD±R DL/DVD±RW/CD-RW)
Battery and power:	Built-in 60-watt-hour lithium-polymer battery 60W MagSafe power adapter with cable management Mains voltage: 100V to 240V AC
Installed software:	Mac OS X v10.6 Snow Leopard (includes Time Machine, Quick Look, Spaces, Spotlight, Dashboard, Mail, iChat, Safari, Address Book, QuickTime, iCal, DVD Player, Photo Booth, Front Row, Xcode Developer Tools), iLife (includes iPhoto, iMovie, GarageBand, iWeb, iDVD)
Physical:	Height 2.7cm, Width 33cm, Depth 23.2cm Weight 2100g

We liked:

- Super-fast, even old applications work at warp-speed
- The elegance of the Mac design
- The screen – super-bright, saturated and clear
- Turning the Mac on all angles does not cause the hard-drive to make protest noises
- The silence
- Almost total lack of viruses
- Encrypted mode
- The magnetic power supply connector – breaks away if stressed
- 7-hour battery – may be a little optimistic, but is outstanding
- Runs cool on your lap for hours
- Front Row - shows superb HD movie trailers
- The software supplied out of the box and pre-loaded
- The Dock – software and documents easily accessed along the bottom of screen
- The piano-finish, with a rubberised base, to stop slipping off

Not so much:

- The DVD SuperDrive is about .5mm too narrow, so some DVDs clatter a little
- A VGA-to-mini-socket adaptor must be bought for a second screen or projector
- WMV needs a download (Mac's native software is Quicktime)
- The instruction manual is lacking for new Mac users, though a menu in the top of the screen accesses 'Help'

apparently Apple "encourages" the same price through all stores and dealers, by not offering huge discounts to the larger outlets.

Ready to go

Out of the box, Mac comes with iLife, enabling users to make movies, do all manner of music work and make websites, without buying new applications.

If you communicate with PCs, the MacBook can open and view plus save Microsoft Word.

The Apple image application 'Preview' is exciting too. Open almost any image graphics format including Photoshop, then adjust colour, tint, size, sharpness and re-save in a choice of many formats, like JPEG, gif and PDF.

This simple application works so well, so fast, so easy, I've stopped opening Photoshop for basic image manipulation, like resizing and a quick tweak of colours.

PDF is native

Apple has an incredibly useful feature – the ability to save almost every document in PDF. It's not as an add-on software, rather it's built into every 'print' menu. Page layouts or web pages can be saved as a PDF for perfect viewing with full layout and clickable web links.

So others see the layout and fonts, identical to the original document – even if the PC user doesn't have the fonts in the original document. This is also brilliant for saving copies of business documents and purchases, like eBay, in the format seen on screen at the time.

Won't break the bank

Add the Apple iWork software suite for just $129 and the MacBook can do all but the most heavyweight assignments. Included in iWork are three applications – 'Pages' for brilliant page layouts and brochures, (not unlike InDesign, Quark or PageMaker), 'Numbers' for graphs and number-crunching plus tables and finally 'Keynote,' a layout for presentations, so graphic-featured it makes 'PowerPoint' look boring.

Templates enable documents like Invoices, with automatic GST calculations and brochures to be customised in minutes.

Talk to PCs

To extend communication with PCs, a native version of Microsoft Office Suite is available for Mac OS X with a Mac-friendly interface to create documents in Word, PowerPoint and Excel, so you can easily share documents with friends and colleagues.

Would all PC users benefit from the transition to Apple? No, in the real world, students and some business people may have best interchange and training with their peers by being on the same platform. Apple has made enormous efforts to bridge this gap however, making sometimes unpopular changes to ensure PC users are able to make the transition much easier.

A survey at a leading Melbourne University found that Apple users are 17% more productive (quicker) than those on PCs. This alone is a good reason to consider Apple.

With Snow Leopard, Mac has out-of-the-box support for Microsoft Exchange Server 2007, something even Windows PCs don't have.

So you can use your Mac — with all the features and applications you love — at home plus at work and have all your messages, meetings, and contacts in one place.

More fun – securely!

If you are ready to move from PCs, then consider Apple, for ease of use, creativity, platform stability and almost zero viruses. Mac OS X doesn't get PC viruses.

Moreover, with virtually no effort on your part, Mac OS X protects itself from other malicious applications. Every Mac has a secure configuration, so Apple intimated Macs don't need antivirus software.

Nevertheless, having no protection still has some risk, especially if you are exchanging documents with PC users. In that event the Mac may have no problem with a virus but unprotected, can be a 'carrier' so its worth having protection. In addition, a Firewall can be set up, to avoid nasties like phishing.

Security is further improved by Apple's inbuilt FileVault, which encrypts or scrambles the data in the home folder so that unauthorised users, applications, or utilities can't access your data.

It does need to be turned on though, so some will miss this useful feature.

Outstanding connectivity

Using a HP printer on the MacBook for the first time was amazing. Instead of searching the web for drivers, after attaching the printer's USB lead, a window appeared, asking 'would you like to connect to the HP2750?'

In just a minute or two, the Mac had invisibly searched for the latest driver, downloaded it and a print menu appeared.

When reviewing the MacBook, it was constantly a surprise to find new and old functionality working so well. The MacBook has not crashed once and it's simply the most exciting computer I've ever used. PC users be aware - try out a MacBook and you may be hooked!

Apple is ready for a new slogan: 'MacBook – it just works. . . SC

ALTRONICS

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Extend the range of your remote control!

A standard infra red (IR) remote is great if you're in front of the telly, but what if you're in the kitchen or study? This kit converts infra-red to long distance RF signal adding up to 30m range to your remote - even through walls and floors. The RF transmitter simply fits in place of a battery inside your existing remote control. Includes power supply.

K 11750 **$109** RRP $129

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Allows one person to test continuity and polarity of two core cables using a base unit and remote LED. The base unit provides visual & audible indication of continuity, whilst the LED indicates polarity. Supplied with high quality silicon test leads. Includes 9V battery.

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The easy way to move data from one drive to another. Suits 2.5" or 3.5" SATA hard drives. Enables fast 'hot swapping' of drives whilst the PC is on. A must for IT technicians! USB2.0 or eSATA. Includes power supply. *Hard drive not included

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Great for charging iPods, MP3 players, PDA's, phones & portable game consoles from any 100-240V power outlet anywhere in the world! Includes Australian, US, UK & European adaptors.

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Combines a spring loaded ratchet wire stripper, cutting blade and kwik-connect crimper in a single tool. Saves space in the toolbox! Suits 10-24 AWG cable. Crimps red/blue/yellow kwik connectors

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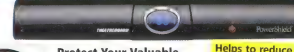
Helps to reduce your power bill!

Powershield® Theatreguard Remote Control 8 Way Power, Phone & Aerial Protector

This stylish device protects equipment from spikes & surges **PLUS** it cuts power to appliances when not in use, vastly reducing your standby power usage. Unit can be operated using your existing equipment remote controls. LCD readout shows how many watts are being consumed. 8 protected mains outlets, plus aerial (PAL & F Type) & telephone (RJ11) protection. Size: 442Wx112Dx45.5Hmm.

P 8140 **$149** NEW!



Handy Wireless Mouse With Laser Pointer

Mini wireless laptop mouse with inbuilt laser pointer. Intense laser beam operates up to 50m. Samsung/Pleomax brand. 2 buttons with scroll wheel.

Great for lectures and presentations!

U 3005 **$45** RRP $49.95

In-Car USB Camera & Digital Video Recorder.

Records full motion video+audio to an internal 8GB Compact Flash memory card. Ideal solution for monitoring fleet vehicle use, providing instant evidence for personal injury claims, traffic infringements etc. In vehicle footage is helpful when analysing accidents, malicious damage, driver assaults, security & law enforcement etc. Ideally used in service vans, buses, coaches, heavy machinery, even boats. Employ's a low light Sony CCD sensor for night and day time operation. Includes PC software for file archiving and footage playback.

Powered by your cars accessory socket!

S 9430 **$399** NEW!

Keep an eye on Altronics Silicon Chip advertisements for more exciting new products arriving soon!

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Digital TV – *where to from here?*

Freeview with MPEG-4 *should* be the answer!

Digital TV commenced in Australia on 1st January 2001 – yes, nine years ago, making Australia one of the first countries to start regular DTV transmissions. These transmissions now cover 60% of the population but for Australians to get full HD programming, we need MPEG-4 broadcasts. At present, we are being short-changed.

By ALAN HUGHES

What has happened with Digital TV since 2001? As far as programming is concerned, the answer must be "Not much!"

Sure, the networks can now transmit both SD and HDTV but there is little that is true HD - and most HD is merely simulcast with the SD programs anyway. Believe it or not, a lot of the do-called "HD" programming is itself up-scaled from SD, which means that it might fill a large screen but quality-wise, it's no better than the SD program.

We'll explain the important difference between HD and true HD (or more correctly Full HD) shortly.

However, on the reception side, there have been considerable developments. Over the last few years, a large proportion of the population has upgraded their TV sets to large-screen LCD or plasma HD sets. Many people have also purchased Blu-Ray players which are recorded at the 'Full HD' standard. When connected to a display with an HDMI or component video

You don't have to pay a lot to get Freeview Certification (whatever that actually means – Freeview won't tell anyone!). This HD Set Top Box was recently being offered through ALDI stores for just $99 – and that includes MHEG-5 interactive middleware enabled, MPEG2 and MPEG4 AVC format decoding and 1080i/720p/576i display modes.

cable, many large-screen TVs and projectors will display the image at this quality. But free-to-air broadcasters and Pay-TV operators do not transmit signals at the 'Full HD' standard.

Freeview

We've also been "blessed" with a raft of "new" digital TV programming under the "Freeview" banner but as viewers well know, that hasn't meant much in the way of new programs.

In fact, during 2009 TV channels were forced to change their advertising which claimed Freeview offered a whole lot more than it delivered.

With only a few exceptions, most new Freeview channels are simply copies of existing channels.

As we said earlier, Australians are being short-changed and there is no sign that this is going to change any time soon. But Freeview is more than TV stations transmitting new digital channels. It's actually a whole new set of technical standards including (but not limited to) the ability to receive MPEG-4 signals.

It's almost impossible to find out what the Freeview specifications are, unless you are a manufacturer or importer willing to sign a non-disclosure agreement.

However, even without the specifications, we can use the Freeview marketing and labelling to ensure any TV set purchased now will be ready for MPEG-4 when it finally arrives.

What is MPEG-4?

The Motion Picture Expert Group (MPEG) is a body which lays down standards. Australian Free-to-Air TV and SD satellite TV currently use the MPEG-2 standard.

In 2007, MPEG-4 was introduced, which creates signals with 30 – 50% smaller data rates than with MPEG-2. The result is that a Full HD signal can now be sent with a data rate of only 8Mb/s.

MPEG-4 is presently used only on HD satellite transmissions including Foxtel, handheld TV, plus a number of Free-To-Air (FTA) ground-based TV services, including all New Zealand DTV.

Semiconductor manufacturers are now making MPEG-4 decompressor ICs. These will also decompress MPEG-2 because it is a subset of MPEG-4. As a result, there should be no significant increase in receiver price due to the inclusion of MPEG-4 decoding.

For example, Aldi stores have been selling a Freeview-approved STB for a similar price to other, non-MPEG-4-capable, HD STBs.

TV precedents

When colour TV was introduced to Australia, there were no separate monochrome and colour transmitters. All receivers, even B&W sets, could display a watchable program from the same transmission.

The former equivalent of the ACMA specified that all colour receivers had to incorporate a delay line for colour correction. As a result we had no simple-PAL sets and assuming there was enough signal at the aerial, all colour sets gave good pictures.

Similarly, when UHF TV was introduced, even if the TV receiver didn't have a UHF tuner (and very few did not) just about everyone had a VCR. All video recorders were equipped with a UHF tuner allowing the vast majority the audience to view UHF as well as the original VHF programs. This enabled all broadcasters to roll-out UHF transmission to many regional areas.

But now, with digital TV, we have separate HD and SD program streams. They could have completely different content but for the most part, they both have identical programs.

Since HD broadcasts started, the price of HD set-top-boxes has plummeted; SD STBs have virtually disappeared from the shops. (Even if SD are still available from your local retailer, we recommend against purchasing them – even if they appear to be an absolute bargain!)

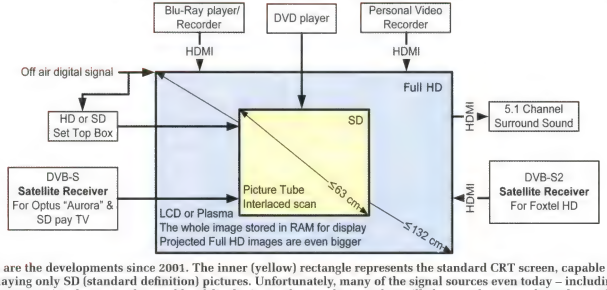
Action required

What we need now is for the Depart-

No money for MPEG-4?

Free-to-air TV stations constantly bleat about insufficient revenue to allow them to adopt new technology such as MPEG-4.

But with the Federal Government's $250 million largesse to free-to-air licencees in the form of slashed licence fees (*The Australian*, February 8), surely there is now just a little left in the coffers to stop short-changing Australian TV viewers and switch on MPEG-4?



Here are the developments since 2001. The inner (yellow) rectangle represents the standard CRT screen, capable of displaying only SD (standard definition) pictures. Unfortunately, many of the signal sources even today – including off-air "HD" TV signals – are only capable of displaying at this resolution. This will change – but it needs to change faster!

A comparison of relative screen sizes from SD, through the various incarnations of "HD", right up to the full or true HD (in light blue). As this graphic ably demonstrates, even discounting SD, without full HD you are being well and truly shortchanged. And you cannot (yet!) receive full HD signals off-air.

ment of Broadband, Communications and the Digital Economy and the Australian Communication and Media Authority to insist all importers that all receivers must be able to produce a viewable program from a Full HD MPEG-4 program.

To enable broadcasters to switch over to MPEG-4 receivers need to be able to decompress all MPEG-4 signals, whether they are Full HD or SD. This will then make the need for transmitting an identical SD version of the HD program unnecessary.

Even though MPEG-4 offers broadcasters a number of advantages (see tables), experience has shown they loathe spending money: they won't switch over to MPEG-4 until they are confident that receivers can decompress all MPEG-4 signals.

As an aside, in the USA, all colour TV transmissions were to the NTSC standard until 2007. Now NTSC broadcasts have stopped and US TV signals are HD ASTC digital only. So while the USA started digital TV after Australia, they have moved ahead of us with their HD ASTC digital TV.

As a result, there has been a considerable increase in the number of HD original programs – which we don't see! So plenty of HD programs are available and probably most US-originated TV series we are presently watching are available in HD – at no extra cost!

So, to set the ball rolling, we need just one TV broadcast network to start transmitting MPEG-4 programs. The others will follow suit just so they don't suffer any marketing disadvantage.

Developments since 2001

Currently, we have a model of three commercial broadcasters plus the ABC & SBS. Usually this means five transmitters on five separate channels. Digital TV is more efficient in the use of the spectrum, enabling more than one program to be transmitted by a single transmitter. Local digital TV stations are now radiating extra program streams: TEN and One HD, Nine and GO!, Seven and Seven HD, while the ABC now has ABC2 and ABC3 with SBS also transmitting SBS2.

Costs for the broadcasters

Provided the entire audience can receive the MPEG-4 programs, the largest cost is the infrastructure used to produce HD programs. The distribution costs are unchanged with the exception of the purchase of HD MPEG-4 compressors for each program stream at the playout centre.

Satellite television

Currently the Optus Aurora satellite is feeding low powered repeater transmitters and direct-to-home receivers in remote areas of Australia. This system is DVB-S which uses SD MPEG-2 compression.

Towards the end of this year the Optus D3 satellite will be launched. To transmit HD through a satellite DVB-S2 is required as it uses MPEG-4 compression and improved error correction. Foxtel HD is already using DVB-S2. This has enabled them to minimise their satellite hire costs for HD programs.

The conversion task in Australia

There are about 7.9 million dwellings in Australia. There are 4.2 million dwellings yet to get their first digital receiver.

Australia has around 17 million TV sets. Eight million of those sets need to be replaced or at least, used in conjunction with a Set Top Box.

The Switchover Taskforce of the Department of Broadband, Communications and the Digital Economy (DBCDE) is funding set top boxes for aged, disability, DVA pensioners, along with carer and DVA income support recipients.

The Tender should mandate that only MPEG-4 capable Set Top Boxes be supplied, and where satellite receivers are required, they must be DVB-S2. For reliable DTV reception the tender should also mandate that no antennas designed for any channel between channel 0 – 5A can be supplied.

This means that by the start of 2014 at least 53% of households will be able to view HD MPEG-4 signals. Some current DTV viewers will need to feed their digital TV with an MPEG-4 capable Personal Video Recorder or STB because their existing decompression is only capable of MPEG-2. You may have noticed that HD Set Top Boxes are now 10% of the price they were in 2001.

Country Western Australia has no commercial DTV. GWN (Prime WA) and WIN are yet to announce a commencement date. Since they only intend to have one digital transmitter per site then the use of MPEG-4 would give either Full HD TV or a greater variety of SD programs. Without commercial DTV there is a much lower proportion of digital TVs. With a viewing population of 500,000 this would be a good place to start using MPEG-4.

The ABC's Role

Virtually all of the programming on ABC HD is upconverted ABC1. This does not make the image quality any better than ABC1. The commencement of ABC3 (Childrens channel) would have spread the existing data rate too thin.

So the ABC would be better off converting ABC HD to Full HD using MPEG-4. This would require an MPEG-4 encoder for each state so that the local news will be available on ABCHD so the channel doesn't need to be changed. Even better if they also use an additional MPEG-4 compressor for ABC3. This will accelerate the sales of MPEG-4 capable receivers.

Conclusion

To future proof TV all new receivers must:

- be able to display a full HD MPEG-4 program
- have at least 1 HDMI V1.3 input, and STB/PVRs an HDMI output
- be MHEG-5 capable
- be 24p display capable (Blu-Ray compatible)
- All Australian satellite transmissions should be DVB-S2 to enable all of us to have the option of Full HD TV.

Importers and manufacturers need to indicate in the specification section of the User's Manual and on their websites what their receivers are capable of.

Broadcasters and the regulators need to bite the bullet and start limited Full HD transmissions with a view to a complete conversion to MPEG-4 transmission at the start of 2014, the start of all digital transmission. This includes the Optus Aurora Free to Air satellite service, which is also used to feed many country transmitters.

If DVB-S2 is used then the demodulated satellite signal can be fed into the ground based transmitter without the need for changes in compression.

Now that the major US networks are HD capable to their viewers and the Europeans are starting HD transmissions, it is time that our broadcasters use the HD versions of programs where possible.

We now have the situation in Australia where an increasing percentage of the audience have better performing equipment than the broadcasters. The lack of Full HD broadcast programs is making manufacturers and retailers' claims of excellent quality false (except for Blu-Ray disc playback).

What is needed is a decision from the DBCDE and Freeview for a start date for the above and an instruction to all importers and manufacturers to implement it. This follows the precedents they set in the past. SC

Which set to buy?

If you are in the market for a TV, PVR or set top box, which model should you buy? The best answer is to buy one labelled "Freeview Approved" since all such products are capable of MPEG-4 decompression. This applies to all Australian and New Zealand "Freeview Approved" models.

Another option would be to look for the Standards Australia ticks, unfortunately the "Australian Standard 4933.1 – 2009 Digital television - Requirements for receivers - VHF/UHF DVB-T television broadcasts" draft has been placed on hold by Standards Australia, pending the availability of resources. This standard is not mandated by law.

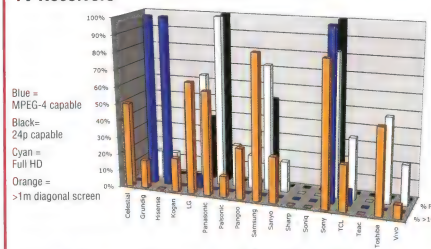
You could also look in the specifications section of the user's instruction manual, however many manufacturers do not specify what compression standards the device can decompress. Download the manual from the manufacturer's website or look at the manual in the store.

Contact the manufacturer or importer and ask them.

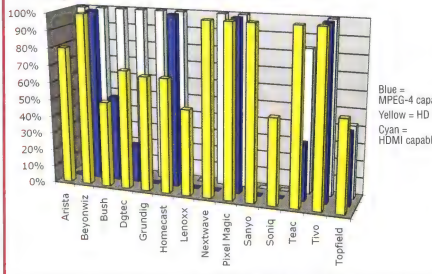
Which receivers are currently capable of MPEG-4 decoding?

The European Union is proposing that all DTV receivers sold after 1st January 2012 should be able to decode MPEG-4 also called H.264/MPEG-4 AVC standard.

TV Receivers



Set Top Boxes and Personal Video Recorders



The data for the above graphs is constantly changing so some brands may be missing or have a greater percentage of the characteristics shown in the graph. The data was obtained from a survey of websites, including downloading the instruction manuals and requests for information from the manufacturers. Most did not reply.

A year on from the 2009 Victorian Bushfires, a possible life-saver goes begging . . .

Defined Area Early Warning System

You can sense the frustration in this first-hand account of the design and development of an effective, targeted and most of all affordable natural disaster warning system. Developed specifically in response to those terrible bushfires of a year ago, everyone who sees it says "fantastic!" So why is it languishing in some bureaucrat's "in" tray?

It is difficult to travel anywhere in Victoria without coming across reminders of the fires that took so many lives on Black Saturday, February 7th 2009.

The tragedy in one way or another touched us all and the depth of the generosity shown to those directly affected was truly admirable.

Like so many others I also wanted to do something that would help prevent loss of life when, as it surely will, similar circumstances arise in the future.

As an electronics engineer I thought that there must be a better way to get information to those in areas of high risk, to help them make the right and timely decision about when to activate their prepared fire safety plan – that is, whether to leave while it is still safe to do so, or to stay and defend.

The inspiration.

The inspiration that I was hoping would come finally arrived on 14th October, when I heard on the news that as part of the Unified National Bushfire Strategy there would be firstly; a common Fire Danger Rating (FDR) and that secondly; the ABC was to be responsible for broadcasting the FDR and fire threat warnings by radio. I immediately thought of using radio to carry the warning information in a digital format to a dedicated receiver to those in areas specifically at risk of fire at the time. As any designer knows, the inspiration is the easy part...

What would it look like?

The initial concept of the receiver included the following requirements:

- Be able to display in real-time the current threat level for the area that it is physically located in,
- Be inside the radio footprint of a carrier that would remain reliable throughout the duration of the emergency,
- Have backup power to continue to provide service in the case of loss of mains power,
- Be operationally reliable, physically robust and suitable for low-maintenance installations in rural areas,
- Be easy to manufacture, cheap to buy and easy to install.

by David Ambry
Engineering Manager,
Nexus Technologies Pty Ltd

The choice of carrier

I had heard something of Telstra's telephone-based National Emergency Warning System (NEWS) system by this time but thought that it had some severe limitations that would be hard to overcome. It seemed to be intrinsically complex and I felt that local infrastructure damage and high traffic use

The Sam receiver, developed by David Ambry and the team at Nexus Technologies, as part of the DAEW System, can be used as a stand-alone installation or may be supplemented with external sirens and visual threat-level indicators – or even control automatic spray and sprinkler systems etc.

in emergency situations would make it particularly vulnerable to failure, just when it is most important that the messages be delivered.

I felt that augmenting the system with another delivery mechanism, something that worked in parallel with the Telstra system, would vastly improve the reliability of information delivery to those who required it, when they required it.

My recent tenure designing satellite telephony systems based on Iridium resulted in this being initially considered a candidate but was quickly ruled out on grounds of cost. (It may well be being used by Telstra to deliver SMS where there are currently no copper connections.)

Next up for consideration was the broadcast band AM radio, as it is ubiquitous in rural Victoria and by nature of the long wavelengths used, propagates well.

A bit of investigation revealed that there was an augmentation of AM that provided a data channel – Amplitude Modulation Signalling System or AMSS.

Unfortunately AMSS has not been embraced by Australian broadcasters and also suffers from a very slow data rate. Therefore it was ruled out as a contender.

The newly introduced Digital Audio Broadcasting (DAB+) service was also a candidate, albeit only briefly. As DAB is intrinsically digital, providing a data channel for threat messages is easy but there are other limitations that ruled DAB out.

For example, the high frequencies involved with the DAB band (174 to 239MHz) make it affected by diffraction, absorption and multi-path effects, meaning that reliable operation could not be guaranteed for anything less than a line-of-sight installation between transmitter and receiver.

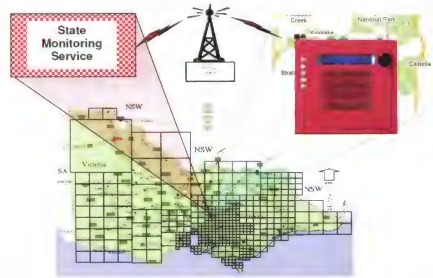
But most importantly, DAB is currently only available in urban areas – no use at all to the high-risk areas that need to be served.

That left the FM band as the one serious candidate.

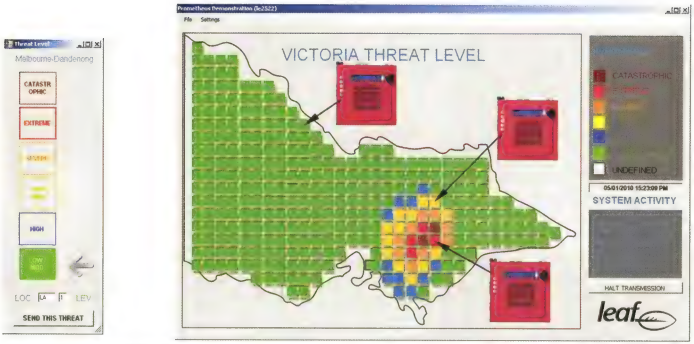
The FM standard includes RDS or Radio Data System, a method of transmitting data by way of a separate sub-carrier that is a simple enhancement of station equipment and importantly, has been widely adopted.

An analysis of the available data on transmitter coverage and fire risk estimate maps showed that an estimated 90% of the population in the higher fire risk areas would be capable of receiving ABC FM transmissions.

The rest was simple. The centralised co-ordinated controlling bodies would provide the fire threat information for the state, the FDR information delivered to the transmitters by Internet and then broadcast to the special receivers that would display the information. There was nothing technically that could not be done.



The State Monitoring Service receives the locality-specific fire information and assigns a threat level to the relevant cells. The information is then delivered electronically to the FM transmitters and transmitted to the Sam receiver.



The Prometheus demonstration application runs on a PC and connects to the FM transmitter by internet. Each and every cell is able to be assigned its own threat level.

The soft sell

With the complete design mapped out in my head, it was time for the next hurdle – trying to sell the idea to my employer.

Explaining the system and the building block elements that we already had to the owner of the company went surprisingly well. He was very receptive to my idea and I was allowed time and budget to fast-track a trial system.

I am a senior Design Engineer at Nexus Technologies Pty Ltd, an Australian company that designs and builds high-quality, low volume Audio/Video equipment. One of the products that we already manufacture and sell is an FM tuner with RDS that I designed several years ago.

A problem remained however: how to get the FDR messages only to those in areas that were under threat of bushfire attack. The initial proposal was that only those in the listening area, the radio 'footprint' of the given transmitter would receive the threat messages and those outside this area would simply not receive the data.

Adjacent area transmitters would use different frequencies and receivers would be programmed to only listen to their stations.

It would work but the coverage areas would be poorly defined.

A method that provided a well-defined cellular division of area was required. I decided to break the state up into an x-y grid with each area thus defined being given a unique designator address. This also allowed for variable-sized cells; there could be smaller cells in high population-density, high-risk areas and larger cells in low-density, low-risk areas.

Each receiver would be allocated its cell designator at installation time as well as the frequency that it would be tuned to.

Indeed, the system now became frequency-independent so that the receiver could have a list of backup frequencies to attempt in the case that the primary radio station should fail. The transmitters would continually transmit each and every cell's designator and associated FDR threat level. The receiver would decode all messages but only display the information for its programmed area.

The perspiration

The design concepts and outline were well received by the rest of the engineering team and we began to prototype the system.

The project was given a suitable acronym – the Defined Area Early Warning (DAEW) system and consisted of the receiver (codenamed Sam) and the software to drive the transmitter (codenamed Prometheus).

Aran Gallagher, a talented hardware and software engineer, rapidly developed the Prometheus software while Eddie South, indispensable engineering technician, sourced a low-power RDS-capable FM transmitter (commonly called an exciter) and set up an aerial, counterpoise, RF attenuator and Ethernet to serial bridge.

I adapted our existing tuner design to deliver the RDS messages via serial port to an external display and decoder and within a month of elapsed time we had a crude but demonstrable system.

Initially the system only displayed the standardised FDR text for each fire threat level on a single-line 16-character Liquid Crystal Display.

It's a poor design that doesn't achieve any enhancements during the normal course of development and naturally the DAEW improved during the process resulting in a second-generation or pre-production Sam receiver by late November 2009.

The improvements included the following:

- The addition of an audio amplifier and speaker that would be automatically switched on whenever the FDR escalated to deliver any audible messages that might accompany the change.
- Front-panel high-intensity 10mm LEDs in the appropriate FDR colours that would light to show explicitly the

FDR for the receiver's cell.

• Amother LED was also added to indicate a day of Total Fire Ban for the cell.

• Drivers and connectors for an external siren and status display.

• Finally, uncommitted relay contacts were included. The relays are energised when the threat level is above the Low/Moderate level and at the Catastrophic level, the idea being to drive auxiliary equipment such as a roof sprinkler system.

If transmitted, each cell can have its Time To Impact (TTI) estimate transmitted, though this doesn't need to be done as often as the FDR data as the receiver can run an autonomous countdown timer to keep the display of this estimate updated.

We also concluded that cells could be updated at different rates and that we could be transmitting the FDR information to critical cells more often than to those that were under no threat.

Sam uses a flexible software guard timer, with different decision thresholds for different FDRs, to advise of any loss of received code in the allocated time. This naturally led us to propose self-escalation of FDR in the event of signal failure but this was deemed unwise for obvious reasons.

As the receiver recovers each and every cell's status information, we also decided that the complete state situation map could be recovered at any receiver site using software that is something like the inverse of Prometheus connected to the serial port of Sam.

This may be of use to local authorities that need to be advised of the overall situation.

The Sam receiver is housed in a simple sheet-metal enclosure, being robust and cheap to fabricate. It might not win any styling awards but this is a case of form simply following function.

The overall dimensions of the enclosure were driven by the need for a large internal speaker for good audio efficiency and the size of the internal SLA backup battery. The power input accepts any voltage from 8 to 40VDC to charge the SLA battery, so will accept power from a 12V plug pack or 12V to 24VDC Remote Area Power Supply (RAPS) source.

A 1m fibreglass whip antenna is used as the receiver's aerial – plugging straight into the antenna socket, although a remotely-located high-gain Yagi might be required in areas where the RDS signal is marginal.

We had trimmed the core design of the Sam receiver down to a level where we had a viable business model that would deliver a small but acceptable profit margin selling the basic unit at a price of $100 on a production run of no less than 10,000 units.

That was the easy part!

The design complete and tested, suitable for demonstration and the value of the solution undeniable, we thought we had a system that could not fail to generate widespread interest.

We had ready access to CFA volunteers and demonstrated the DAEW system to them with encouragingly enthusiastic responses. It was time to see what the government and the appropriate authorities thought of it, introduce it to the media and see if the ABC would embrace the concept.

We enlisted the help of Louis Delacretaz, former Mayor of the Shire of the Yarra Ranges, a qualified engineer himself and someone extremely concerned about raising the fire threat awareness level of people that live in these areas.

Louis immediately understood and embraced the DAEW system concept and agreed to help champion our cause with the authorities.

A meeting was held in early December with James Merlino MP at Parliament House. James lives in Monbulk, right in the middle of the Dandenong Ranges high fire-risk area and was Louis' choice as he felt James might best understand how the system would serve the community.

The DAEW system was favourably received at the meeting and we were asked to provide a detailed system description and report which would be presented to the Premier of Victoria, John Brumby. We are now waiting on a formal response to our system implementation proposal.

We have made tentative steps in making the media aware of the DAEW system but have yet to generate any interest. It would seem that just having a better mousetrap doesn't mean that people are automatically going to be interested in it.

We also approached the ABC to determine their capability to provide the RDS transport mechanism. Submitting a formal query resulted in a wait of almost a month before we were provided a response:

"In short, no, the ABC doesn't support RDS for any of our radio broadcasts in Australia... the ABC experimented with the technology in the early 1990s but back then, not many receivers were able to decode the broadcasts."

We simply cannot believe that the ABC has exciters that do not have RDS capabilities. The cost of RDS subcarrier functionality is insignificant compared to the rest of the infrastructure costs of FM transmission.

If their equipment is more than 30 years old, it may not have this function but I'd be prepared to bet that all their station racks have an exciter with a DB9 RDS input socket that is connected to nothing.

Where to from here?

We were, in all honesty, naively optimistic that the DAEW system would be rapidly and enthusiastically embraced. After the Internet information site fell over at the first whiff of summer smoke we were seriously considering whether we could roll out perhaps a thousand units by February for immediate deployment in some of the highest risk areas.

If the ABC couldn't or wouldn't assist, maybe regional and community FM stations might be willing to host the RDS traffic.

Compared to last year it's been a cooler and wetter summer but it's always late summer; February and even into March that are the driest months and present the greatest hazards.

Here we are – at the time of writing (end January) and we've not had a word of response from the government.

By the rules of simple good manners, that would indicate that DAEW is still being given serious consideration. We can but live in hope!

Further reading

www.cawcr.gov.au/bmrc/wefor/projects/fire_wx_workshop_jun_05/08gould.pdf (The map on page 3 shows the potential for disastrous bushfires).

www.cfa.vic.gov.au/about/documents/7th_Feb_2009_Fires_Overview_Map_A3 (An Interim Summary Overview map of the 7th February 2009 fires shows the predictions to be very accurate). SC

benchmark
MARCH 2010

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SAVE $16

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This solidly built switch-mode power supply provides well-regulated 13.8V DC output with a 23A current rating. Highly RF resistant, it is ideal for powering transmitters and other high-current loads in engineering and servicing applications. Features include an internal thermally switched cooling fan, heavy-duty DC banana terminals, a strong metal case, and extensive overload protection. Q1755

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Cordless, quick ignition, butane-powered soldering iron kit, includes 1mm soldering tip, hot knife, 'heat blower' and blow torch tips plus solder and a tip cleaning sponge. Includes handy carry case. T1103

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An aggressive Contact Cleaner for use in cleaning metallic switch contacts in the general electronics area e.g. TVs, PC boards, computers and phones. Not for use with plastics. Highly flammable. 190g can. Not carried at all stores, but can be ordered in. N1124

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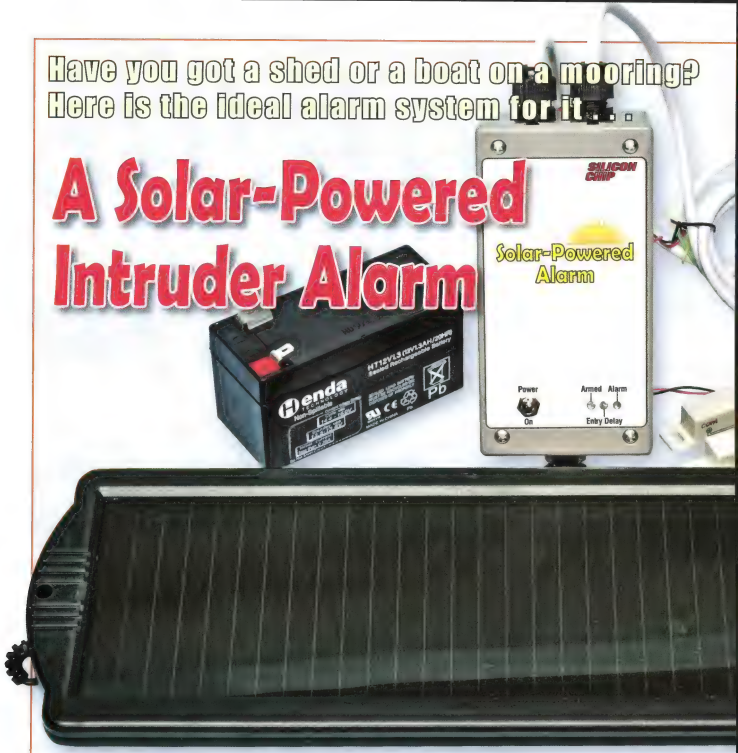
Terms and conditions: offers start 22/02/10 and end 31/03/10 or while stock lasts. No rainchecks. No layby. Offer may not be available in some reseller or franchise stores.

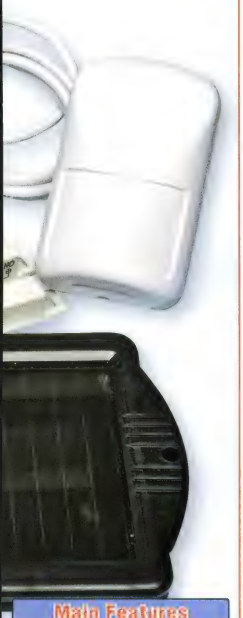
Have you got a shed or a boat on a mooring?
Here is the ideal alarm system for it . . .

A Solar-Powered Intruder Alarm



Most blokes have got a shed – or wish they had! While many people have alarms for their home and cars, a lot of valuable stuff is unprotected in garages and sheds. It needs protecting and now you can do it with this simple alarm based on a PIR sensor. It's solar-powered so no mains supply is needed. And let's not forget boats on moorings – they need protecting too.

By JOHN CLARKE



Specifications

Supply Voltage: 12VDC

Supply Current: 3mA during exit delay; 500µA with PIR connected while armed; 2.5mA plus 10mA for siren during alarm

Exit Delay: 22 seconds

Entry Delay: approximately 5s to 30s adjustable

Alarm Period: approximately 25s to 147s (2.5 minutes) adjustable

Armed Flash Rate: approximately once per second

Armed Flash Period: approximately 22ms

Main Features

- Three inputs
- Voltage input for PIR
- Instant or delayed option for each input
- Exit delay
- Entry delay
- Low quiescent current
- LED indicators
- Battery powered
- Solar cell battery charging

WHETHER YOU LIVE in the city or a rural area, it is likely that you have a shed with lots of valuable gear inside – tools, machinery, electronic equipment, sports stuff, maybe a boat – you get the picture. And we'll bet that it has no protection apart from a lock on the shed door. Maybe you have thought about the problem but it was too hard and there is no mains power out there and so on.

Now you can greatly improve security for all that valuable gear with our Solar-Powered Alarm. As well as utilising a PIR sensor it has two other inputs, so you can wire it up to suit your situation.

Now we know that there are plenty of burglar alarms available but most are too costly and complex to suit a shed – or a boat for that matter. You don't need multiple sectors, back to base security etc – just a simple set-up with a loud siren.

As a bonus, the simplicity of a basic alarm means a lower power requirement and it becomes practical to power the system from a battery that is charged from solar cells.

We have specified a PIR (passive infrared) sensor intended for use with battery equipment where low current drain is a major consideration. It operates from a 5.5-16V DC supply and its current drain is quoted at less than 100µA at 6V.

We measured current drain on our sample unit to be 70µA at 6V and 73µA at 12V. When movement is detected, the current rises to 1.3mA to light its indicator LED.

In its simplest form, the Solar-Powered Alarm can be used with just the PIR detector. For a shed, it is best installed inside so that it is only triggered when somebody enters. For extra protection, reed switches can be added to monitor windows.

If you want to build this alarm for a boat, the PIR sensor is probably not practical because sun glinting off the water could cause nuisance triggering. In this case, you would be better to rely on reed switches or a strategically placed pressure mat.

Sensor triggering

Sensor triggering can be instant or delayed. Delayed triggering allows you to enter the shed and switch off the alarm before it sounds. This would be applied to the PIR sensor if it monitors the entry point. Other sensors can be set for instant triggering.

All told, there are three inputs on the alarm, each selectable for instant or delayed operation. However, that does not restrict the number of sensors to three. Most reed switch and doormat sensors can be connected in parallel so that any sensor that closes will trigger the alarm.

Circuit details

The complete circuit of the Solar-Powered Alarm is shown in Fig.1. It looks a little complicated but there is not a lot in it. It employs four low-cost ICs and associated components. The three inputs are labelled Input1, Input2 and Input3. Input1 is provided specifically for the PIR detector.

The output of the PIR sensor is normally 0V but when it detects movement, it goes high to +4.5V. Its output impedance is about 700kΩ, so Input 1 employs Mosfet Q1 to provide a very high input impedance. Hence, when the PIR signal goes to +4.5V, it switches on the Mosfet and its drain goes low, to 0V.

Q1 controls pins 12 & 13 of IC1d, a dual-input exclusive OR (XOR) gate. Both inputs are high at +11.4V when

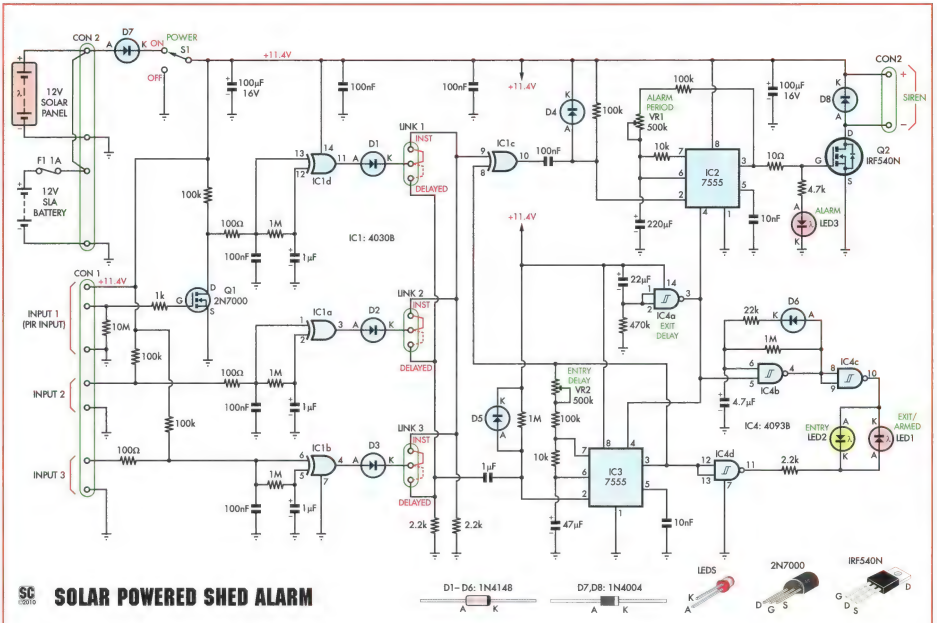


Fig.1: the circuit is based on a 4030 quad exclusive OR gate (IC1a-IC1d), two 555 timers (IC2 & IC3) and a 4093 quad 2-input NAND gate (IC4). IC2 sets the alarm period, IC3 sets the entry delay period and IC4a sets the exit delay period. IC2 also drives the siren via MOSFET Q2. Power comes from a 12V SLA battery which is charged by a 12V solar panel.

Q1 is off. When Q1 switches low, it discharges the 100nF capacitor at pin 13 via a 100Ω current limiting resistor. With pin 13 low, the 1µF capacitor at pin 12 then discharges via the series 1MΩ resistor over a period of about one second.

IC1d's output at pin 11 is high only when the inputs differ from each other. So when pin 13 is initially pulled low by Q1, pin 12 will remain high for a short period while the 1µF capacitor discharges. So pin 11 is high during the period that the 1µF capacitor at pin 12 is discharging.

When Q1 switches off, the 100nF capacitor at pin 13 quickly recharges via the 100kΩ resistor to the 11.4V supply. The 1µF capacitor at pin 12 is delayed from charging due to its 1MΩ charging resistor. So again, IC1d's output is set high for about a second.

As a result, IC1d's output produces a high-going pulse whenever Q1 is switched on or off by the PIR sensor.

Inputs 2 & 3 operate in a similar way to Input 1 except that no Mosfet is used and the 100nF capacitor is discharged via the normally open (NO) sensor contacts between input and ground (0V). The 100Ω series resistor reduces peak current through the contacts to less than 120mA.

We recommend using NO sensor switches because if normally closed (NC) switches are used, the 100kΩ resistor connecting to the 11.4V supply would add an additional 114µA to the overall current drain of the circuit.

Triggering

The three XOR gate outputs (ie, IC1a, b & d) are coupled via diodes to links which give the option of Instant and Delayed triggering.

The instant option connects to pin 9 of IC1c which is normally held low by a 2.2kΩ resistor. A high signal from the output of IC1a, IC1b or IC1d will pull pin 9 high and pin 10 of IC1c will go high whenever the pin 8 input is low (which is most of the time).

Hence, each time one of the XOR gate outputs goes high, pin 10 will produce a brief positive pulse of the same duration. This pulse is coupled via a 100nF capacitor to the trigger input of IC2, a CMOS 7555 wired as a monostable. This is the Alarm Period timer. It determines how long the siren sounds after the alarm has been triggered.

Normally, pin 2 of IC2 is pulled high via the associated 100kΩ resistor and since IC1c's output is normally low, the 100nF capacitor will be fully charged. Then, when pin 10 of IC1c goes high momentarily, it attempts to force pin 2 of IC2 above the positive supply, because of the positive charge on the 100nF capacitor. However, diode D4 prevents this from happening and any excess voltage from the capacitor is safely limited.

After the short positive pulse from IC1c, pin 2 will then be briefly pulled low via the 100nF capacitor and this sets monostable IC2 running for its predetermined alarm period. Pin 3 will go high and this will turn on Mosfet Q2 which then drives the external siren connected to CON2. LED3 is also lit, indicating an alarm condition.

At the same time, the 220µF capacitor at pin 6 begins to charge via the 100kΩ resistor and 500kΩ trimpot VR1. When it reaches $^2/_3$ the supply voltage, the timer is switched off, with pin 3 going low. At the same time, pin 7 discharges the 220µF capacitor via the 10kΩ resistor.

Note that the resistors from pin 7 are connected to the pin 3 output of

Parts List

1 PC board code, 03103101, 59 x 123mm
1 UB3 plastic utility box, 130 x 68 x 44mm
1 low-current PIR detector (IR-TEC IR-530LC) (Altronics SX-5306) – do not substitute
1 12V 1.3Ah or larger SLA battery (Altronics S-5075B, Jaycar SB-2480)
1 12V solar cell trickle charger with integral diode (Altronics N-0700, Jaycar MB-3501)
1 12V siren (Altronics S-6125, Jaycar LA-5258 or equivalent)
1 SPDT toggle switch (S1) Or
1 SPDT key-operated switch (Altronics S-2501 – see text)
3 IP68 cable glands PG67 type
3 3-way PC-mount screw terminals with 5mm or 5.08mm spacings
2 2-way PC mount screw terminals with 5mm or 5.08mm spacings
1 9-way pin header broken into three 3-way headers with 2.54mm pin spacing (Link1-Link3)
3 PC stakes
3 jumper plugs for above headers
4 4.8mm female spade connectors
2 4.8mm male spade connectors
1 60mm length of 2mm heatshrink tubing
1 150mm length of 0.71mm tinned copper wire or 5 x 0Ω resistors
1 length of 4-core alarm cable (length is installation dependent)
2 500kΩ horizontal-mount trimpots (code 504) (VR1,VR2)
1 in-line 3AG fuse holder
1 3AG 1A fuse

Semiconductors
1 CD4030 quad Exclusive OR gate (IC1)
2 ICL7555, LMC555CN CMOS 555 timer (IC2,IC3)
1 CD4093 quad 2-input NAND gates (IC4)
1 2N7000 N-channel Mosfet (Q1)
1 IRF540 N-channel Mosfet (Q2)
6 1N4148 switching diodes (D1-D6)
2 1N4004 1A diodes (D7,D8)
2 3mm red high-efficiency LEDs (LED1,LED3)
1 3mm green high-efficiency LED (LED2)

Capacitors
1 220µF 16V PC electrolytic
2 100µF 16V PC electrolytic
1 47µF 16V PC electrolytic
1 22µF 16V PC electrolytic
1 4.7µF 16V PC electrolytic
3 1µF 16V PC electrolytic
1 1µF monolithic ceramic
6 100nF MKT polyester
2 10nF MKT polyester

Resistors (0.25W, 1%)

1 10MΩ	1 4.7kΩ
5 1MΩ	3 2.2kΩ
1 470kΩ	1 1kΩ
6 100kΩ	3 100Ω
1 22kΩ	1 10Ω
2 10kΩ	

Optional Additional Parts
SPDT reed switches & magnets (Altronics S-5153, Jaycar LA-5070 or equivalent)
Pressure mat (Altronics S-5184 or equivalent)

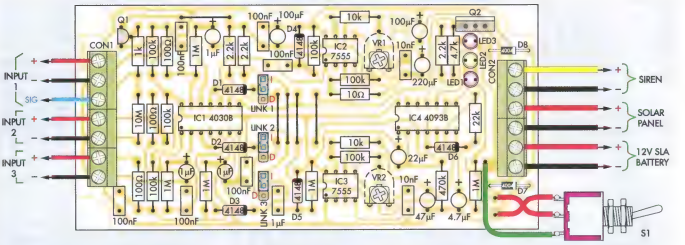


Fig.2: follow this layout diagram to install the parts on the PC board. Take care with the orientation of the polarised components and position Links 1-3 to select either instant or delayed triggering for each input.

IC2 rather than the 11.4V supply. This arrangement is used to minimise current drain.

Exit & entry delay

An exit delay is needed so that when you power up the alarm, you have time to get out of your shed (or boat) without triggering the siren. Switch S1 powers up the alarm circuit. When power is applied, the 22µF capacitor at pins 1 & 2 of IC4a is initially discharged and this sets the output of this Schmitt NAND gate low, to hold the reset for both the IC2 and IC3 timers low. This prevents IC2 and IC3 from being triggered.

The 22µF capacitor then charges via the 470kΩ resistor and after about 45 seconds or so, the voltage reaches the lower threshold for IC4a's input and its pin 3 output goes high. Thus, pin 4 on both IC2 & IC3 goes high and both of these timers can now be triggered, ie, the alarm circuit is fully operational.

IC3 is another 7555 wired as monostable timer and is used for the entry delay. It is triggered if one of the links (Link1 to Link3) is set for delayed triggering. The trigger pulse for pin 2 of IC3 is coupled via a 1µF capacitor. One side of the 1µF capacitor is normally held low via a 2.2kΩ resistor to ground while the pin 2 side is held high via a 1MΩ resistor.

Again, the triggering process is similar to that for IC2. When a high signal is applied from one of the diodes, D1, D2 or D3, the 1µF capacitor discharges via the now forward-biased diode D5. When the delayed signal side of the capacitor goes low, the pin 2 input to IC2 is pulled low to trigger the timer.

The pin 3 output of IC3 will then go high for the entry delay period which is set by trimpot VR2. This holds the pin 8 input of IC1c high and this prevents IC2 from being triggered.

The entry delay can be set anywhere between five seconds and 30 seconds.

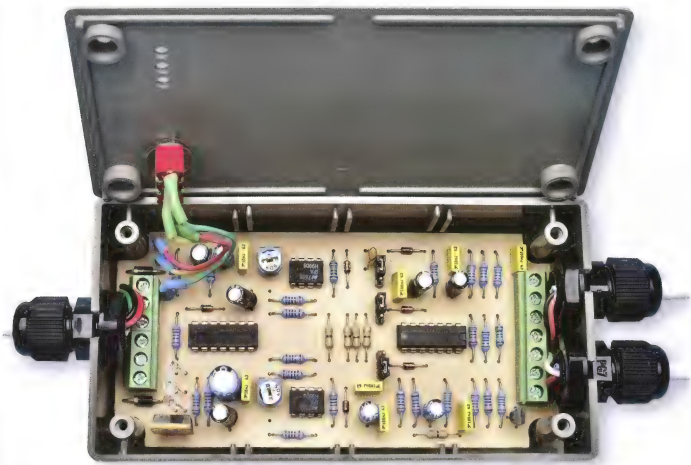
Let's clarify a point here. When we talk about Entry Delay, we are referring to the delay which is available when any of the three input sensors closes, provided that Delayed Triggering has been selected by the link options provided by Link 1, 2 or 3 (or any combination of the three).

LED indicators

During the exit delay period, pin 5 of Schmitt NAND gate IC4b is held low and its pin 4 output remains high. IC4c inverts this high and so its output at pin 10 is low. Pin 3 of IC3 is low (since IC3 is currently disabled) and so pin 11 of inverter IC4d is high. The combination of pin 11 being high and pin 10 being low means that LED1

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	10MΩ	brown black blue brown	brown black black green brown
❑	5	1MΩ	brown black green brown	brown black black yellow brown
❑	1	470kΩ	yellow violet yellow brown	yellow violet black orange brown
❑	6	100kΩ	brown black yellow brown	brown black black orange brown
❑	1	22kΩ	red red orange brown	red red black red brown
❑	2	10kΩ	brown black orange brown	brown black black red brown
❑	1	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	3	2.2kΩ	red red red brown	red red black brown brown
❑	1	1kΩ	brown black red brown	brown black black brown brown
❑	3	100Ω	brown black brown brown	brown black black black brown
❑	1	10Ω	brown black black brown	brown black black gold brown



This is the view inside the completed prototype. Note that you will have to make the wiring connections to the screw terminal blocks before sliding the PC board into the case and installing the cable clamps.

is lit continuously for a period of 45 seconds which is the Exit Delay.

After the Exit Delay period, the pin 3 output of IC4a allows normal operation for timers IC2 and IC3. It also allows the oscillator based on IC4b to operate by pulling pin 5 high. This now flashes LED1 at about once every two seconds.

The duty cycle of the oscillator is only about 2% so while the flashing of LED1 is highly visible, the overall LED current drain is very low.

During the entry delay period, IC4d's output at pin 11 is low so LED1 is off and green LED2 is on, but not continuously. This is because the oscillator based on IC4b is still running and LED2 turns off very briefly every two seconds.

At the end of the Entry Delay period, IC3's output (pin 3) goes low again and pin 11 of IC4d goes high. This causes LED1 to flash again and the alarm will sound, since IC2 has been enabled. This lights LED3 and sounds the siren connected to Mosfet Q2.

Of course, if the Entry Delay was triggered by you, entering in a legitimate way, you will have had time to turn off the alarm and the neighbourhood will not be disturbed.

Construction

The Solar-Powered Alarm is constructed on a PC board coded 03103101 and measuring 59 x 123mm. This PC board is designed to clip into the integral mounting clips inside a UB3 plastic case.

Fig.2 shows the assembly details. Begin construction by checking the PC board for breaks in the tracks or shorts between tracks and pads. Repair these if necessary. Check also that the hole sizes are correct for each component. The screw terminal holes are 1.25mm in diameter compared to the 0.9mm holes for the ICs, resistors and diodes.

Assembly can begin by inserting the links, diodes and resistors. We used 0Ω resistors in place of wire links although tinned copper wire links could be used instead. When inserting the resistors, use the resistor colour code table to help in reading the resistor values. A digital multimeter can also be used to measure each value.

Table 2: Capacitor Codes

Value	µF Value	IEC Code	EIA Code
1µF	1µF	1u0	105
100nF	0.1µF	100n	104
10n	.01µF	10n	103

The diodes can be installed next and these must be mounted with the orientation as shown. The four ICs can then be mounted directly on the PC board or using sockets. DIP14 IC sockets are required for both IC1 and IC4 and DIP8 sockets for IC2 & IC3.

Ensure that each IC is placed in its correct position and is oriented correctly with its notch or pin 1 indicating dot oriented as shown. The two trim-

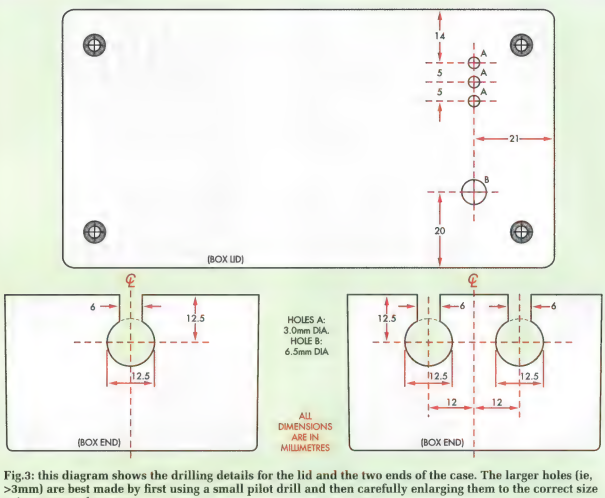


Fig.3: this diagram shows the drilling details for the lid and the two ends of the case. The larger holes (ie, >3mm) are best made by first using a small pilot drill and then carefully enlarging them to the correct size using a tapered reamer.

pots can now be mounted, followed by Mosfets Q1 and Q2, taking care with their orientation. The multi-way screw terminals can then go in, noting that the 7-way terminals are made using one 3-way and two 2-way sections. The 6-way terminals are made using two 3-way sections.

The three LEDs are mounted with the top of each LED 28mm above the PC board. Take care with orientation. The anode has the longer lead.

Follow with the capacitors, ensuring that the electrolytic types are oriented correctly. Finally, insert and mount the three 3-way pin headers and the three PC stakes.

As mentioned, the PC board is designed to clip into the integral side clips within the box. The box requires holes to be drilled in each end for the cable glands. Note that there are also 6mm slots cut from the top edge of the box to the cable gland holes. These are there to make assembly possible, but more on this later. Holes are also required in the lid for the LEDs and power switch. Fig.3 shows the dimensions for these.

Wiring

The wiring for the switch and siren is shown in Fig.2. The switch wiring is soldered to PC stakes on the board and the connections covered with a 10mm length of heatshrink tubing to prevent them from breaking. The external siren is connected to the screw terminals.

Testing

To test the unit, connect a 12V supply to the "+" and "-" terminals on the PC board, apply power and check that LED1 lights. If LED2 lights instead of LED1, then the orientation of LED2 is reversed. If neither LED lights, check LED1's orientation.

The length of time LED1 stays fully lit is the Exit Delay period. This delay is not critical but it does need to be sufficient to allow an easy exit from the shed after switching on the alarm without setting it off. You can change the exit period by changing the capacitor value at pins 1 & 2 of IC4a.

A smaller value will reduce the period while a larger value will give a longer period.

Select each input for either instant or delayed triggering using the jumper pin option for each input. Note that an input will be disabled if there is no jumper connection.

When red LED1 begins to flash, the alarm is ready to be triggered. Connect a wire between the two contacts for input 2. For an instant alarm selection, red LED3 should immediately light. For a delayed selection, green LED2 should light. When LED2 extinguishes, LED3 should light.

If the siren is connected, it will also sound but due to its loudness, you may wish to disconnect this during testing. Alternatively, you could connect a piezo sounder instead.

The Alarm Period can be set with trimpot VR1. Clockwise rotation in-

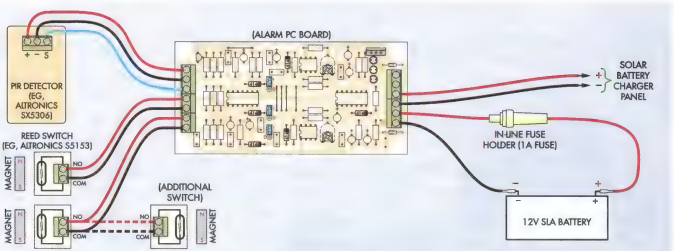


Fig.4: the PIR detector and reed switch sensors are connected to the PC board as shown here. Not shown are the connections to the siren and the on/off switch. Be sure to use a 1A fuse in series with the battery supply.

creases the period while anticlockwise rotation reduces the period. The Alarm Period only needs to be long enough to attract your attention to the fact that there may be an intruder. An extra long alarm period is not necessary.

The Entry Delay period is set using trimpot VR2. This period should be as short as possible but still provide sufficient time for you to gain entry to the shed to switch off the alarm. Final adjustment will be best done after the alarm system is installed in the shed (or boat).

Installation

Wiring for the Solar-Powered Alarm is dependent on the installation. It depends on the number of sensors used and the distance between the sensors. Wire lengths are also dependent on the location of the battery and the solar cell in relation to the alarm unit.

The solar panel should be mounted on the roof of the shed and in Australia should be set facing north. Northern Hemisphere installations will have the solar cell unit facing south. Inclination should be roughly 23° up from horizontal for NSW. Higher angles are required for areas south of NSW, while lower angles are required for northern Australia. However, the actual inclination is not critical. Provided it's in the ballpark, the solar cell output will be more than adequate to keep the SLA battery charged unless the alarm is repetitively activated each day.

Decide on the type of sensor you will use with the alarm. Typically, a reed switch and magnet are used to monitor a door or window. The magnet is installed on the moving part and the reed switch mounted on the fixed part.

A PIR detector and some SPDT reed switches make ideal sensors for the Solar-Powered Alarm. Fig.4 shows how they are connected.

The normally open (NO) contacts of SPDT reed switches should be used, to provide a lower current drain from the battery. These contacts are open when the magnet is close to the reed switch but close as the magnet moves away from the reed switch.

The NO contacts can be connected in parallel so that more than one window or door can be monitored on one input. However, the door entry reed switch should be connected to a different input than the window sensors, so that the window inputs can be set to an instant alarm. The door entry is normally set for a delayed alarm to allow entry into the shed to switch the unit off.

The PIR sensor should be mounted so that it covers as much of the shed as possible. You can test coverage by connecting a 12V supply to the PIR detector, temporarily mounting it in

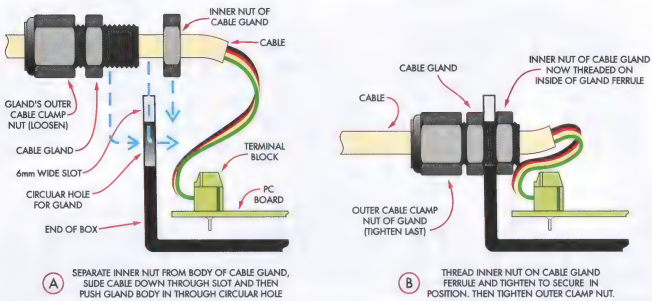
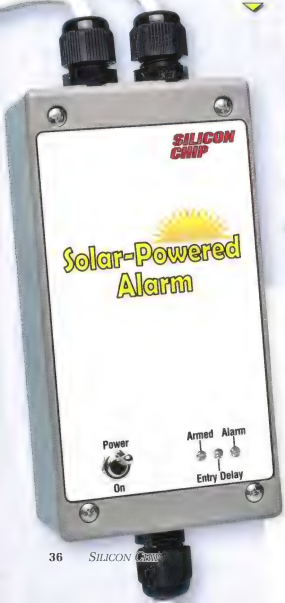


Fig.5: the cable glands are slid into the case slots and secured after the leads have been secured to the screw-terminal blocks, as shown here. Note that the outer cable clamp nut is tightened last.

Below left is the completed prototype. You can either use a toggle switch for power on/off or a remotely mounted key switch (see text).



position and watching the detector LED light as you move around the shed.

Note that while we used a toggle switch on the Solar-Powered Alarm to switch it on and off, an SPDT key switch could be used instead. This key switch could then be mounted outside near the door of the shed, so that the alarm can be switched on and off from outside the shed. Suitable key switches are available from Altronics (Cat. S-2501).

Alternatively, you could use a DPST key switch such as the Altronics S-2520. **However, note that you must convert it to a SPDT switch by connecting its two common terminals together.**

Using a key switch allows the entry delay to be set to a very short period or set to instant. Note, however, that the Exit Delay needs to be at least a second to ensure that the Solar-Powered Alarm is reset properly at power up. The Exit Delay capacitor should therefore be at least 2.2µF.

The external siren should be mounted high in an inaccessible position and the wiring to it hidden so that is can

At right is another view inside the completed prototype. We used 0Ω resistors for the links but you can use tinned copper wire instead.

The Altronics N-0700 12V solar-cell trickle charger includes an integral diode and is used to keep the 12V SLA battery topped up. At right is the full-size front-panel artwork (also available on the SILICON CHIP website).

not be cut. Suitable sirens are available from Altronics, such as the Cat. S-6117, S-5415 or S-6120A.

External wiring

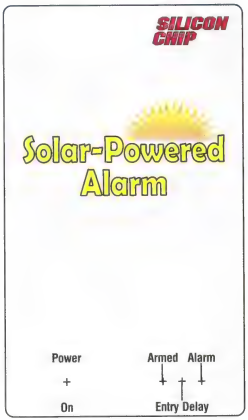
The wiring for the battery, solar cell and trigger inputs is shown in Fig.4. This wiring can be done with the PC board out of its box and with just the wiring passing through the cable glands. The glands are not secured into the box until later.

Wiring for the PIR uses 4-core cable and this is passed through its own cable gland. One of the wires is not used and is cut short. Another cable gland is for the Input2 and Input3 cabling and this also uses 4-core cable.

4-core cable is also used for the to the battery and solar cell. **Use an in-line fuse holder for the positive battery connection.** The battery wires are secured to 4.8mm female spade connectors using a crimp tool. These connectors plug into the spade battery terminals.

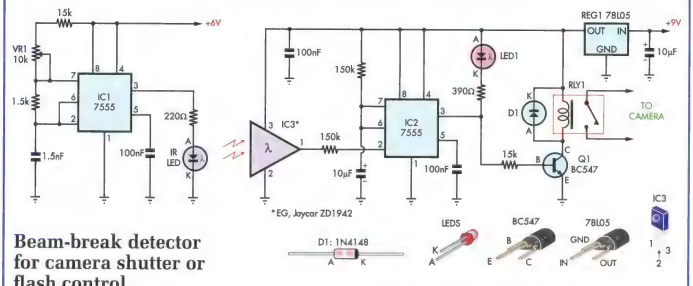
The solar-cell charger is supplied with a lighter plug on the end of its lead. This can be cut off and 4.8mm female spade connectors attached instead. These can then go to male spade connectors that are attached to the solar cell leads from the alarm unit.

When assembling the Solar-Powered Alarm into its box, firstly clip the PC board into the box and place each cable gland securing nut inside the box and the gland on the outside of the box. Pass the cable wires through the slots as shown in Fig.5. Tighten the gland to the box against its nut and then clamp the cable in place with the cable clamp. SC



CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.



Beam-break detector for camera shutter or flash control

This circuit is presented as an alternative to the IR beam break detector featured in the June 2009 issue. In order to make it relatively insensitive to ambient light, it uses a standard IR receiver IC such as the Jaycar ZD-1942. This has a high output (+5V) as long as a modulated beam is detected.

The IR detector (IC3) controls an LM7555 CMOS timer (IC2) which operates in monostable mode. When the beam is broken, IC2 is triggered and its pin 3 output goes high for about half a second. This extinguishes LED1 and turns on transistor Q1 to drive a 5V low-power relay.

The circuit is powered from six AA cells and a 78L05 5V regulator (necessary for the receiver IC).

The IR transmitter is also built around an LM7555 (IC1), this time operating in astable mode at low duty cycle. Its frequency is set to 38kHz with trimpot VR1. The IR diode was salvaged from a defunct remote control but these are readily available new. The transmitter is powered by four AA cells.

The system has a range of several metres and while it is insensitive to the transmitter alignment, the detection window can be narrowed by placing the detector near to the object to be detected and/or using some form of baffle to restrict the window.

Graham Jackman,
Oakleigh East, Vic. ($40)

Capacitance meter is based on reactance

This capacitance meter circuit is intended to be used with a digital multimeter but its principle is quite different from the Capacitance Adaptor project published elsewhere in this issue. Whereas that circuit effectively responds to pulse propagation delay this one relies on a sinewave voltage source and measures capacitor current.

The block diagram of Fig.1 shows the general configuration whereby the capacitor to be tested, Cx, is part of an integrator. It measures capacitors in the range from 1nF to 100nF but this can be extended to 10µF.

As shown in Fig.2, an external 2kHz sinewave generator signal is fed to the input of IC1a which is wired as an integrator which effectively feeds the capacitor with a constant current. Its output voltage is proportional to the capacitor's reactance. This is fed to op amp IC3 which is switched to have a gain of unity, 10 or 100.

IC3's output is AC-coupled to op amps IC2a & IC2b which function as a precision rectifier. IC2b's DC output is fed to a logarithmic converter based on op amps IC1c & IC1b, together with transistors Q1 & Q2. This has the function $-\log_{16}N$ where N is the DC voltage at its input, ie, the output of IC2b.

Finally, the output of the logarithmic converter is fed to an exponentional converter based on op amp IC1d and transistors Q3 & Q4. This converts its input voltage ($-\log_{16}N$) to a linear-related output current, in the collector load of Q3.

When the logarithm and exponential converters are combined in this fashion, an inverse variation function is preformed. What happens is the formula for capacitive reactance $1/2\pi fCx$ becomes $2\pi fCx$, ie Xc is divided into 1.

Furthermore, this capacitive susceptance is multiplied by a reference

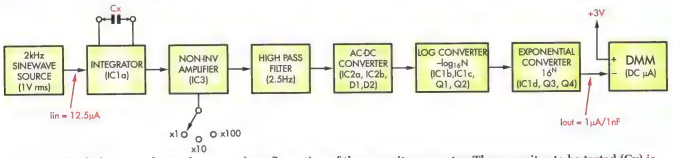


Fig.1: this block diagram shows the general configuration of the capacitance meter. The capacitor to be tested (Cx) is part of an integrator and is fed a constant current.

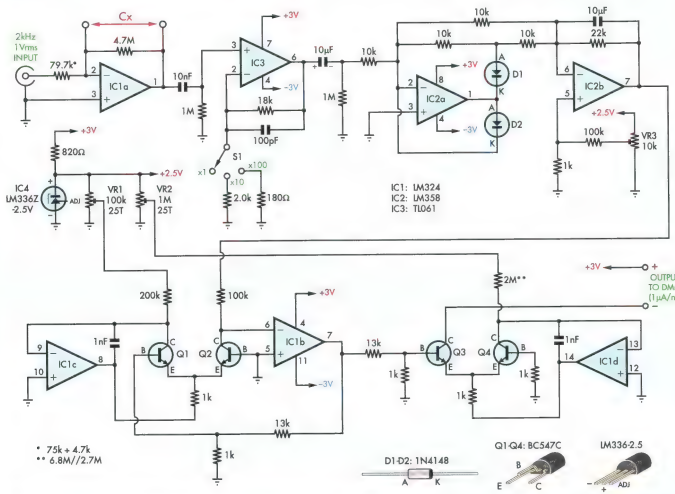


Fig.2: the output from integrator IC1a is amplified by IC3 and fed to a precision rectifier based on op amps IC2a & IC2b. IC1c, IC1b, Q1 & Q2 form a logarithmic converter, while IC1d, Q3 & Q4 function as an exponential converter.

current, fed to the collector of Q4, to give the final output function of 1µA per nanofarad (1µA/nF). For example, if Cx is 47nF then the digital multimeter will read 47µA.

Op amp IC1d allows the emitters of Q3 and Q4 to sit at a negative voltage, allowing their base-emitter voltages to be compared. This gives rise to the exponential function.

Note that for a +1.0V DC change at the input of the logarithm converter, there is a corresponding 40dB change in output current (1µA to 100µA). So by using logs with base 16 and utilising the output as a current source, the DC supply voltages can be compressed down to ±3V, making the circuit suitable for battery use.

The capacitance range can be extended another 40dB by inserting additional voltage gain between the integrator and the AC-DC converter. This is the function of IC3.

Calibration should be done at 25°C. To calibrate the unit, use a 1nF capacitor for Cx and set the sinewave to 1V at 2kHz. This should give +1.0V DC at pin 7 of IC2b. Adjust trimpot VR1 until the output of IC1b reads 0V, then adjust VR2 until the multimeter displays 1µA. VR3 is used to offset null op amp IC2b.

Malcolm Sharp,
Berala, NSW. ($70)

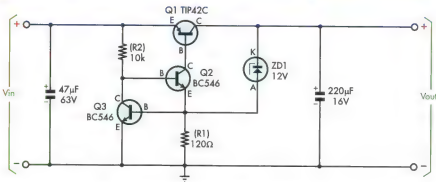


FIG.1: FIXED BIPOLAR LDO REGULATOR

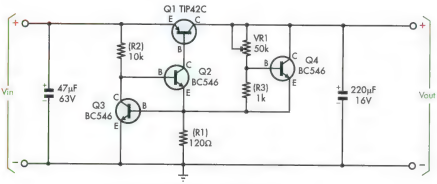


FIG.2: ADJUSTABLE BIPOLAR LDO REGULATOR

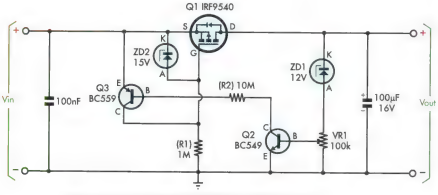


FIG.3: SEMI-ADJUSTABLE MOSFET LDO REGULATOR

Discrete low-dropout voltage regulators

Low drop-out regulators are useful primarily in two circumstances. The first is when you have a low source voltage, such as a battery, and you need a regulated output even when the battery is discharged close to your target voltage. The second is when you need a regulator as a voltage limiter and want to draw substantial amounts of current through it. In this case, if it has a low drop-out voltage, heat dissipation can be minimised as long as the source voltage is not substantially above the desired output voltage.

In the first case, you can probably use a monolithic regulator, such as the LM2940. They are somewhat more expensive than standard regulators but do the job well. However, in the second case there are various reasons why a monolithic regulator may not be suitable. For example, it may be hard to get one with a high enough input voltage or current rating.

Presented here are three discrete designs which are able to act as basic regulators/voltage limiters but use readily available parts and can be easily customised. The first two are also cheap to build, especially if you don't need more than a few hundred milliamps.

The circuit of Fig.1 uses standard transistors and provides a fixed output voltage which can be chosen within about 1V. You can replace the TIP42C with a BC327 if you don't meed more than a couple of hundred milliamps and the transistor dissipation will be kept below 500mW in the worst case. In this case, R1 can be increased to 560Ω to reduce quiescent current.

The circuit works as follows: transistors Q2 & Q3 form a basic current sink to control the base current of Q1, the series pass transistor. Resistor R2 turns Q2 on and as current flow through Q2 increases, so does the voltage drop across R1. When the voltage drop

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across R1 exceeds the base-emitter voltage of Q3 (about 0.65V), Q3 then begins to shunt Q2's base current to ground.

This sets up a negative feedback loop which stabilises the current through Q2 to about 4mA (650/R1). This current is pulled from V_{IN} through Q1, which has the effect of turning Q1 on.

It also forms a crude current limiter, since the maximum current Q1 will pass is its base current times its h_{FE} which in this case means around 400mA or thereabouts. Reducing the value of R1 will increase this limit.

The second feedback system is due to zener diode ZD1. As the output voltage rises above 12V (ZD1's reverse breakdown voltage at low current), the zener diode begins to pass some current into Q3's base. This also reduces the base current to Q2 and thus Q1, so Q1 tends to turn off if the output voltage V_{OUT} rises above 12V.

You can change ZD1 to alter the output voltage, although zeners below about 6V have a higher characteristic impedance so they don't work so well in this application.

Bear in mind that the line and load regulation of this circuit are nowhere near as good as a 3-terminal regulator.

The circuit of Fig.2 is identical to Fig.1 except that the zener diode has been replaced with Q4 which functions as a "V_{BE} multiplier". This works under the assumption that Q4's base current is negligible. If this is true, then the voltage between its collector and emitter will be its V_{BE} times the ratio of VR1 to R3. Thus, by adjusting VR1, we control the drop across Q4 and therefore V_{OUT}.

The circuit of Fig.3 replaces bipolar transistor Q1 with a P-channel Mosfet. The general principle of operation of this circuit is similar to the other two but the detail is a little different. It works as follows: R1 pulls the Mosfet's gate to ground which turns it on. Zener diode ZD2 prevents Q1's gate-source voltage, V_{GS}, from exceeding the safe limit, which is 20V. If you use a different P-Channel Mosfet be sure to check its absolute maximum V_{GS} and if necessary, select the voltage rating of ZD2 accordingly.

Now with Q1 on, the output voltage will increase until ZD1, a 12V zener diode, begins to conduct and pass current to potentiometer VR1 which forms an adjustable voltage divider. Once its wiper exceeds 0.65V, Q2 turns on, sinking current through R2. This turns on Q3, which allows current to pass from V_{IN} to R1. This increases the gate voltage on the P-channel Mosfet, switching Q1 off.

Thus V_{OUT} is maintained at 12V + 0.65V × r, where "r" is the ratio of the divider formed by VR1. As a result, the output of this circuit is adjustable from around 12V and up.

Why not omit ZD1 and just use VR1 to adjust the output voltage? The reason is that Q2's base-emitter voltage has a significant temperature coefficient and this would be multiplied by the ratio of VR1. As a result, the output voltage would vary much more as the transistors warm up and cool down. So the best way to adjust the output voltage is to pick ZD1 so it is slightly lower than the desired output voltage and then use VR1 to set the output voltage, as necessary.

The circuit of Fig.3 has one big advantage – extremely low quiescent current (<40μA in dropout, <150μA in regulation). It also has good line regulation. Testing suggests that it is stable with no load in this configuration.

Because of the properties of the Mosfet, it should be able to deliver several amps, subject to dissipation limits of the IRF9540 and the heatsink fitted, should that be necessary.

Nicholas Vinen,
Silicon Chip.

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Simple FM receiver has pulse-counting detector

This simple mono FM receiver does not require any alignment and hence is easy to build. It also uses a pulse counting detector which provides good quality sound.

The front end is based on an SA612AD double-balanced mixer and oscillator, IC1. Its oscillator is tuned by tank circuit L1 and trimmer capacitor VC1, connected in a Hartley configuration.

Because the intermediate frequency (IF) is rather low at 120kHz, the RF input to the mixer is not tuned. The 470pF capacitor at the mixer output (pin 3) removes most of the high-frequency carrier and the resulting IF signal is amplified by three common-emitter amplifier stages comprising transistors Q1, Q2 & Q3. Because of the low-frequency IF, these amplifier stages have capacitor coupling instead of IF transformers and so no alignment is required.

The 3-transistor IF stage has a bandwidth of 170kHz and a peak at 120kHz. Q3 also acts as a limiter and produces a square wave output.

Tachometer circuit

Transistor Q4 and its associated components form a tachometer circuit (pulse counting detector). Q4's collector current is a train of narrow pulses of constant amplitude and frequency and follows the limiter output. The collector output of Q4 is filtered to become the resulting audio signal. This is passed to audio amplifier IC2 which drives an 8-ohm loudspeaker.

In operation, the FM receiver draws between 50mA and 90mA depending on volume level and can be powered from a 12V DC plugpack. Regulator REG1 provides a 6V supply for IC1. If you use a 78L06, D1 can be omitted and pin 2 of IC2 can be connected directly to ground.

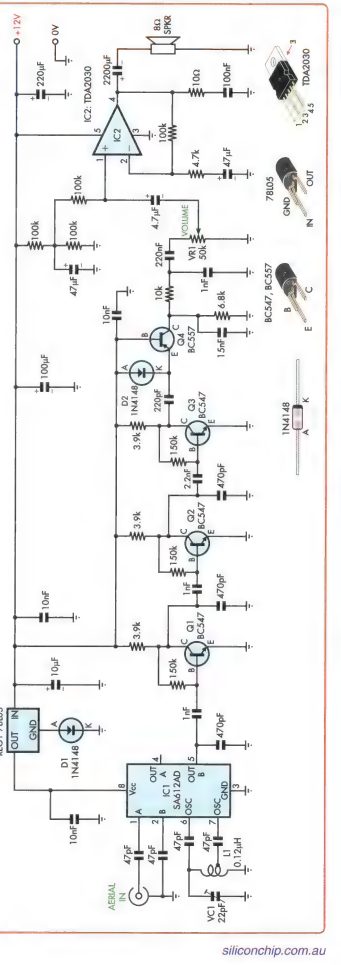
Inductor L1 consists of four turns of 1 mm diameter copper wire wound on a 9mm diameter former and tapped at one turn. The length of the coil is approximately 12mm. It has a nominal inductance of 0.12µH and you may have to either expand or compress the coil (to decrease or increase inductance, respectively) to cover the FM broadcast range, depending on the tuning capacitor used.

Tuning capacitor

The FM tuning capacitor can be salvaged from an old FM tuner. Ideally, the capacitor shaft should have reduction gears which will make tuning in stations much easier. Because of the low IF, you can tune to either side of the centre frequency of the carrier, similar to a "slope detector".

The SA612AD mixer can be obtained from Rockby Electronics and Farnell (both stock the SMD version). RS components stock the DIP version.

Alex Sum,
Eastwood, NSW. ($50)



SERVICEMAN'S LOG

It sometimes pays to keep your mouth shut

Sometimes, it's a good idea to keep quiet about certain jobs, especially when the other party is in a position to return a favour. Such was the case in the middle of England's winter of discontent.

Items Covered This Month

- Jim's induction heater
- Goin' nuclear
- 1950 Philips Radioplayer 124
- 1965 Hacker Sovereign RP18 multi-band AM/FM radio

My first story this month comes from D. D. of Coogee, NSW and concerns a very unusual fault in, of all things, an induction heater. Here's the story in his own words . . .

Many moons ago, when I was much younger than now, I started work in the chemistry department of an English redbrick university. I was a brand new graduate from a university in a nearby town and I think that the main reason I got the job was that the two new professors who interviewed me were originally from the university where I studied and had only recently moved.

I was employed to set up an electronics workshop, which I thought sounded quite grand but things were not quite what they seemed. I knew all sorts of "useless" things like the energy distribution of electrons in common semiconductors and I could calculate the currents and voltages along a twin-wire transmission line using the exponential form of complex numbers. But as to anything practical, well you just had to "learn on the job".

It soon became apparent that the main reason I was hired was that it was much cheaper to have me service all the expensive electronic equipment, rather than call in service personnel from the manufacturers. I did learn on the job and like "The Serviceman", have had many interesting and humorous experiences.

Jim's induction heater

One morning, while sitting in my workshop wondering what I was doing here, the phone rang. It was Jim the glassblower.

Now Jim was one of those old-fashioned characters, a real gentleman and very skilled at his craft but he didn't trust electricity. "I mean, you can't even see it", he would say, "how can all those electrons fit in that tiny wire – it beats me".

I used to try to reassure him that everything could be explained but he was far from convinced.

Anyway, on this particular winter morning Jim was really spooked. "Dave, can you come to the glassblowing workshop straight away? I've just got in and something very strange is happening". So I donned my white lab coat and grabbed my trusty AVO meter and headed off.

When I got there, Jim met me at the

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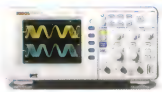

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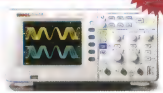

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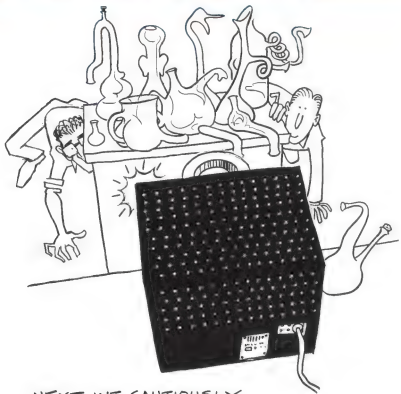


door, grabbed my arm and said "look", pointing at his brand new induction heater, "I haven't even turned the power on yet". So what was wrong?

Well, as with all the university's rooms, there was a distribution board with circuit breakers and a main switch just inside the door. Jim ALWAYS tuned the power off before leaving so he was completely freaked out to see the power indicator light glowing brightly.

I must admit I was a little perplexed as well but I told myself to approach this logically, so I checked and indeed the power was off. Next, we cautiously approached the machine. It was a fairly big box, about 1m high by perhaps 75cm wide, with a perforated metal back and sides. It was basically a big RF oscillator with dials to set frequency and power and a metal ring protruding from the front panel.

The machine was used to join wide glass tubes. Jim had it set up on a raised stand on a side bench so that the tubes could be passed through the metal ring. By now, I was thinking that maybe it was powered from a separate circuit (3-phase perhaps) but why was it not controlled by the main switch?

I was beginning to harbour dark thoughts about incompetent electricians but I was smart enough to realise that I would have to be REALLY sure before I accused anyone of anything.

While I was looking at the machine to see what kind of screws held the sides and back on (and thinking that I didn't really want to start taking the monster apart), I noticed that the red indicator light was no longer glowing. Jim had gone to his bench and had started producing one of his wonderful pieces of glassware so I waited for an appropriate moment to give him the good news.

"Jim the light's gone out now". He put his blowtorch down and came over to look. "You've fixed it. What did you do?", he asked me.

I didn't want to tell him I had done nothing so I paused for a moment to think, staring at the machine for divine inspiration. Then suddenly it came to me! The early-morning winter sun shining through the window and passing through the perforated metal case of the machine had caused the red glow in the indicator light! The reason it was no longer visible was, of course, that by now the sun had risen higher and was not shining through the window!

Eventually, I decided that it was best to come clean, so I told him what had happened. His only reply was "Hmmph! I never did trust electricity! But not a word of this gets out now! OK?"

I never told anyone – Jim was a valuable ally in the constant battle between the academics and the technical staff. Also, it was winter and the coalminers were on strike in protest against Maggie Thatcher's new policies. As a result, there were frequent power cuts, during which no-one could do any work. You could not even normally make a cup of tea, as the urns were electric.

However, Jim could always be relied on to brew up a cuppa in a 2-litre beaker over his Bunsen burner and invite a selected friend to join him – a friend who knew just when to keep his mouth shut.

Goin' nuclear

That first job didn't involve much in the way of servicing skills but the next one wasn't so easy. I had a call from the Professor of Inorganic Chemistry one day – "Can you go and sort out the NMR machine? Brian is in a state and we can't afford to keep calling out the service guys and well . . . that's the sort of thing you do isn't it?"

"OK", I said, "I'll get right on it". You didn't argue with the professor and if he neglected to say "please", well maybe he was just a bit stressed.

The way the university worked is that funding is related to reputation, which in turn is related to the number of research papers published. Each of the three professors had a group of research students and every Monday morning there was a meeting in the academic lunch room where the professors would hand out their assignments. Results were expected by the end of the week and the papers were published under the professor's name along "with" each of the research students (who had done all the work!).

So, of course, if a key analytical machine was playing up, chaos would result.

"NMR" stands for Nuclear Magnetic Resonance – an early precursor of the technology used nowadays in MRI scan machines. In those days, it was

used for its ability to give a fast and accurate analysis of the composition of a small quantity of a chemical sample. The sample was placed in a slim test tube equipped with a little plastic propeller. This was then placed in the NMR magnet and a jet of air was used to spin the sample. A pulse of RF energy of about 40MHz was applied to a coil round the sample.

This RF energy "excited" the molecules which, when they relaxed, produced a characteristic signature which was picked up by the machine. The output was by way of a series of peaks on a paper chart recorder. The chemists, however, were more interested in the area under the peaks rather than the peaks themselves and so an integrator was used to obtain this information.

And that was where the problem lay in this machine. The integrator was drifting badly – so badly in fact, that it was virtually impossible to keep the trace on the paper chart. One minute it would be over 100%, the next heading fast for zero.

Brian the operator was a nice lad and was what we called in those days a "Teddy Boy". He wore stovepipe jeans, thick rubber-soled boots and a leather jacket. The girls all thought he was great but academically he left a lot to be desired and consequently he had no idea what to do about the problem. He was flat out putting the sample in the tube and pressing the start button!

To make matters worse, the manufacturer's service reps had been called several times but to no avail, each man pronouncing that he could find nothing wrong with the machine. The professor was fast running out of patience and money, which is where I came in.

Initially, I could find nothing wrong either. It seemed to be working OK most of the time but every now and then (usually when Brian was doing an important run), it would go berserk and the pen would drift up and down across the chart, ruining the results.

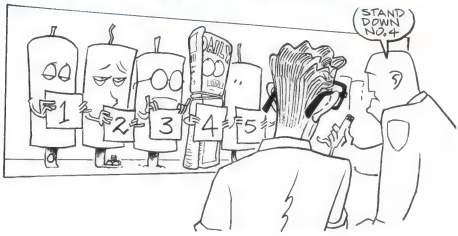
I retired to my lair with the "documentation" – several thick lever-arch folders describing everything from how to install the machine to how to use it. They also had exactly what I wanted – the circuit diagrams.

Anyway, the documentation made great play of the fact that the magnetic field had to be kept extremely stable. The magnet was housed in a box about 2 x 2m wide and 75cm high. It was powered by a complex (valve) constant current supply and the box itself was lined in mu-metal to screen it from outside magnetic fields.

I couldn't think of anything that would cause the problem and eventually decided to give the company a call. Fortunately, I talked to a very helpful Scottish guy who obviously did not want to come out yet again and so was quite happy to talk to me about it. I described the symptoms – which he knew only too well – and we discussed several ideas. "You know one thing you could try", he said, "the integrator capacitor is critical and must not have any leakage current. Maybe there is dust or grease on the PC board, causing leakage. Why don't you try cleaning it?"

Off I went, excited that I might be able to fix the beast. The integrator was one of the units in a 19-inch rack at the back of the machine (why do they always put these things in the most awkward places to get at?). It was soon unscrewed and removed for closer examination.

It was basically an early type of



NEXT, I IDENTIFIED THE 8 WAX PAPER CAPACITORS

my life checking everything around these valves. I changed lots of carbon resistors but after a very long time, finally realised I was barking up the wrong tree.

I talked this over with a friend and he made an interesting comment about the electrolytics used with 6X5GT rectifiers. He told me that it was a mistake to replace them with too big a value, especially right on the cathode. I wasn't convinced but to prove a point, I replaced the 22µF capacitors I had substituted with 10µF units. It made absolutely no difference and it then occurred to me that maybe I had an earth loop problem.

When designing audio amplifiers it is important to have just one earth point (normally at the input). However, in a 60-year-old set like this one, everything is earthed wherever it is convenient. I soon dismissed this idea as the cause of the problem but then thought that maybe the valve filaments were earthed in the wrong spot. However, this wiring all appeared to be original.

I then noticed that when I turned the volume control, the metal shaft was actually sparking! This turned out to be because it was rubbing against the loudspeaker which had dropped onto it. The speaker for some unknown reason is connected to its output transformer which is kept at B+ level! It's a bizarre arrangement and is potentially lethal for an unsuspecting serviceman. No, I kid you not – the circuit diagram clearly shows the screen voltage connected to the laminations of the output transformer. The voice coil of the speaker is grounded.

Finally, I decided to reconnect one of the original electrolytics (C22) which was still in place. And that was when I noticed that it was mounted on an insulator which isolated it from the chassis. The positive went to the HT but the negative didn't go to ground. Instead, it went to the centre tap of the mains transformer!

And that of course was the problem. Rewiring my original 22µF 400V in place killed the hum and the whole radio now performed really well, with great sensitivity.

The Hacker Sovereign

The other radio was an English Hacker Sovereign RP18 transistor set which had spent most of its working life in someone's kitchen but had not been used for a long time. This radio cost over £40 in England in 1965 and really was a class act. It covered the MW, LW & FM bands and featured separate bass and treble controls, an attractive wooden cabinet and a Goodman's loudspeaker.

The circuit uses 15 germanium transistors, so it's quite involved. A drawback is that the FM band only covers from 87-101MHz and not 87-108MHz as later sets do.

Anyway, I replaced the two large PP9 batteries and switched it on. It gave a few "clicks" and hisses from the loudspeaker and then, for a brief moment or two, I got a bit of AM radio. It then went dead.

After trawling the Internet for a short period, I managed to get a service manual and then started by replacing the electrolytic capacitors on all three boards. Getting the chassis out was a challenge at first but basically you remove the handle and its axle screws plus two brass 4BA screws in the corners of the signal boards. The main chassis then comes out through the top. The amplifier board is held by two nuts in the centre.

This radio had an 18V socket on a chrome plate on the lefthand side but this isn't shown in any of the official literature. It was well-made and I suspect it was added by a gifted amateur.

Not being familiar with PNP germanium transistors was a problem, as I did not know quite what to expect. This radio used AF114, AF116 & AF117 transistors in its AM/FM RF/IF strips and AF121 & AF125 transistors in the FM tuner section.

These ancient transistors are difficult to obtain now and the only near-equivalent I could get was an AF139. I don't know a huge amount about germanium transistors but I do know that they can be switched on with just 0.2V (instead of 0.6V for silicon) and that they are all naturally leaky!

Apparently, when a germanium transistor is leaky from its terminals to its shield pin, it is stuffed. Fortunately, I had a small stockpile of some of these old transistors but mine looked even worse than the ones I was contemplating replacing!

I measured the voltages in each stage and they all looked OK. I then decided to replace the transistors one at a time. However, this strategy also had its difficulties as each transistor is mounted on hollow metal legs, making them difficult to remove.

I persevered until I found that changing transistors T2 (AF117) in the MW IF stage and T8 in the FM IF strip restored the sound on all bands. I then retuned the FM local oscillator using C42 to bring in the radio stations above 100MHz and also touched up the aerial trimmer (C35).

Finally, I reassembled the radio and found that it performed very well. Unfortunately though, the AM IF transistor (T2) has now failed twice more (both times intermittently) and I am fast running out of AF117s. Replacing it always fixes the problem but I do not know why it keeps failing. Perhaps I should fit a 7.5V zener to the 7V B+ rail? SC

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Refer: Silicon Chip magazine March 2010

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Cat: AR-3273

Tools, Test & Measurement

IP66 Industrial ABS Enclosures

NEW

Gasket seals, stainless steel hardware and IP66 rated for use in industrial, marine and other harsh environments. The closures have a locking catch that engages to positively hold the lid closed until disengaged. Each enclosure includes a 1.5mm galvanised chassis for mounting DIN rail, switchgear, relays or circuit breakers. A size for any application.

HB-6400

HB-6404

Opaque cover:

Small 125(L) x 125(W) x 75(D)mm	Cat. HB-6400 $16.95
Medium 175(L) x 125(W) x 75(D)mm	Cat. HB-6402 $29.95
Large 200(L) x 200(W) x 130(D)mm	Cat. HB-6404 $34.95

Transparent cover:

Small 125(L) x 75(W) x 75(D)mm	Cat. HB-6410 $18.95
Medium 175(L) x 125(W) x 75(D)mm	Cat. HB-6412 $32.95

Battery Powered 6W Soldering Iron

While 6W won't be enough to solder the Titanic back together, it's plenty for on-site repairs and PCB work. Heats to soldering temperature in about 10 seconds. Requires 3 x AA batteries.

- Size: 175(L) x 36(W) x 18(D)mm

NEW

$19.95 Cat. TS-1535

Auto Ranging Pocket DMM

A handy test instrument worthy of any professional tradesman or handyman's tool kit. This unit has an easy one finger dial selector on the front leaving your other hand free.

- Fixed leads
- Case included
- Display: 5000 count
- Cat II 600V / Cat III 300V
- Basic VDC accuracy: 0.500%
- Shockproof
- Auto power-off

$39.95 Cat. QM-1544

SAVE $20

MORE INFO

Was $59.95

F-Connector Tool Set

NEW

All the tools you need for cutting, stripping and crimping F-connectors for coax cable installations. The kit includes:

- Coax cable stripper
- Compression crimp tool
- Heavy duty cable cutter
- 10 x F-59 plugs
- Nylon storage case: 152(W) x 220(H) x 45(D)mm

$89.95 Cat. TH-1504

Rotary Tool Bit Set - 400pc

SAVE $20

Much cheaper than the hardware store and with 400 pieces, this kit will service every bit you will ever need! Housed in a plastic case.

Contents includes sanding arbours, sanding belts, drill bits, collets, assorted grinding stones and polishing wheels with arbours, TC and diamond burrs, wire brushes, cutoff wheels, buffing mop with paste, paint removing wheel, 250 sanding discs and more.

- Case measures: 210(W) x 300(H) x 70(D)mm

$39.95 Cat. TD-2456

Was $59.95

LED Screwdrivers with 10 Bits

LED illuminated bit driver for working in spaces with poor lighting. The handle has four LEDs built in to provide working light. 10 bits are included, but any standard hex bit will fit. Great for fiddling around under the bonnet etc.

SAVE $8

- Four LEDS to eliminate blind spots
- Bits included: PH #0, #1, #2, slotted 3, 4, 5mm, T15, M6 pin drive, M4 hex, hex 1/4" square converter
- Batteries included, plus a spare set

$14.95 Cat. TD-2091

Was $22.95

Autoranging SMT DMM

Specifically designed for SMT work with interchangeable probes and tweezer probes.

- Continuity test
- Auto power-off
- SMT probes
- Display: 6000 count
- Security class: CAT III 600V
- Basic DC accuracy: 1.5%
- Dimensions: 110(H) x 36(W) x 21(D)mm

NEW

MORE INFO

$79.95 Cat. QM-1496

Low Capacitance Adaptor for DMM Kit

Refer: Silicon Chip Magazine March 2010

Many modern multimeters come with capacitance ranges, but they're no good for very small values. This kit is a nifty little adaptor that allows a standard digital multimeter to measure very low values of capacitance from less than one picofarad to over 10nF. It will allow you to measure tiny capacitors or stray capacitances in switches, connectors and wiring. The kit is complete with PCB, components and case. All you'll need is a 9V battery and just about any modern DMM. Note: Test leads not included.

NEW

$34.95 Cat. KC-5493

Portasol Sale

Portasol Technic Gas Soldering Iron

Compact yet powerful and uncompromisingly reliable, this is one of the most versatile gas soldering irons available. It offers a run time of around 60 minutes, and tip temperature is adjustable up to 450°C. The protective end cap features a built in flint type ignitor, and if the gas is left on, it will turn it off when replaced.

- Dimensions: 170(L) x 19(Dia)mm

$49.95 Cat. TS-1305

SAVE $10

Was $59.95

Portasol 50 Gas Soldering Iron

Powered with standard butane gas, it has a run time of around 30 minutes. Ignition is via the flint igniter at the cap, reaching an impressive 350°C. It is fixed temperature, with equivalent electrical power of around 35W. It features automatic shut-off when the end cap is replaced and fast refill time, 1mm tip supplied.

- Dimensions: 196(L) x 26(W) x 19(D)mm

$29.95 Cat. TS-1300

SAVE $5

Was $34.95

Portasol Super Pro Gas Soldering Tool Kit

This kit contains a Portasol Super Pro Gas Soldering Iron, featuring 90 minute run time, 10 second fill, maximum 1300°C temperature and 40 second heat up.

- Quality storage case.
- Cleaning sponge and tray
- 2.4mm double flat tip (TS-1322)
- 4.8mm double flat tip (TS-1323)
- Hot knife tip (TS-1325)
- Hot air blow (TS-1324)
- Hot air deflector

$139 Cat. TS-1328

SAVE $20

Was $159

Portasol Package Deal

This kit contains a Portasol Pro Piezo Gas Soldering Iron, and all of the following parts:

- Quality storage case.
- 2.4mm double flat tip (TS-1312)
- Hot knife tip (TS-1315)
- Flame tip (TS-1316)
- Cleaning sponge and tray
- Hot air blow (TS-1314)
- Hot air deflector

SAVE $$$

TS-1318 $129

Auto ranging DMM

An excellent, accurate meter that is Cat II rated. It features diode, frequency and capacitance test, duty cycle, continuity, relative measurement and includes battery, probes and holster.

- Display: 4000 count
- 10A AC & DC
- Dimensions: 150(H) x 75(W) x 33(D)mm

QM-1535 $34.95

Buy A Portasol Pro Piezo Gas Soldering Tool Kit (TS-1318) & Auto ranging DMM (QM-1535) For Only $129 Save $34.95

All savings are based on original recommended retail prices. *Limited stock, no rainchecks*

MULTIMEDIA

STEREO BLUETOOTH® ADAPTOR

Add Bluetooth® capability to virtually any audio output device. Just connect your iPod®, mobile phone, CD player, or anything with a 3.5mm audio socket to the Bluetooth adaptor and you can transmit stereo audio signals wirelessly.

- Function range: 10 metres
- Dimensions: 54 (H) x 40(W) x 10(D)mm

Was $49.95

$34.95 Cat: AR-1854

SAVE $15

IPOD® SPEAKER

Designed for the 2nd generation iPod® Shuffle, this stereo speaker is still ideal for use with any iPod® or MP3 player. It produces quality 1W+1W power output sound. Features a protective cover, making it great for use at the beach.

- Requires 4 x AAA batteries
- Size 190(W) x 60(H) x 20(D)mm

Was $9.95

SAVE $3

$6.95 Cat: XC-5189

USB BLUETOOTH® HAND-FREE STEREO EARPHONES

Listen to your iPod® or MP3 player without missing a call from your mobile phone. This tiny device will allow you to answer, hang up and swap between your music source and mobile handset as well as adjusting the volume.

- Supplied with a 1.5m USB lead, 730mm sound source interface lead and bud-style earphones
- Dimensions: 50(H) x 25(W) x 11(D) mm
- Battery: Non replaceable Lithium-ion rechargeable

Was $69.95

SAVE $30

$39.95 Cat: XC-4894

DAB+ MUSIC CENTRE WITH USB & IPOD® DOCK

Enjoy crystal clear digital radio broadcasts, or listen to your MP3s directly from your SD card or USB memory stick. Charge your iPod® or iPhone™ while listening to your daily podcasts, or load your CD and set your alarm so you'll awake the next morning to the sounds of your current playlist favourites.

SAVE $30

- DAB+ & FM digital radio tuner
- iPod® dock, USB port, SD/MMC card slot
- CD player, aux line-in
- Plays MP3, WMA, CD-R/RW
- Measures 310(W) x 115(H) x 185(D)mm

Normally $299

$269 Cat: AR-1752

Note: iPod® not included

NEW

SNAPMUSIC AUDIO CAPTURE FOR PC

Turn your PC into a mini recording studio. Record and archive music from your old vinyl records, cassettes or any other audio source directly to your PC and save the files as high-quality WAVs or MP3s. See website for full specifications.

- Audio capture box with line-in/out, S/PDIF in/out and mic-in all-in-one
- Create your own podcasts from any program material
- Record live performances or lectures
- Convert audio files formats
- Burn high quality audio CDs
- Includes SnapMusic Studio 715 and Roxy Easy Media Creator 9 LE

$89 Cat: XC-4994

NEW

MORE INFO

MICRO USB DIGITAL TUNER

Coupled with a laptop, you can enjoy your favourite HDTV programs from practically anywhere with this USB DVB-T Pico TV stick. Plug into a PC system and tune into your favourite programs with the included software.

- Free-to-air Digital TV (DVB-T)
- Supports Time-shifting allowing you to pause live TV
- Supports scheduled recording
- USB 2.0 interface
- Supports High Definition Digital TV (HDTV)
- Includes mini MCX DVB-T aerial & remote control

$89.95 Cat: XC-4897

NEW

WIRELESS MICROPHONE WITH DIVERSITY RECEIVER

Features a true diversity receiver and 16 user selectable channels. You are sure to get a clear signal from the microphone even when similar devices are used in the area. See our website or catalogue for full specifications.

- Frequency range: 770 - 800MHz

Was $269

$199 Cat: AM-4077

SAVE $100

Also available:
Wireless 32ch Diversity Dual Mic System
AM-4079 Was $499 Now $399 Save $100

PSP® HOME THEATRE DOCKING STATION

Turn your PSP® into a mini home theatre system. However this unit is so portable that you can enjoy surround sound entertainment on your PSP® wherever you go! This PSP® charging station has retractable speakers with built-in amplifier, adjustable vertical stand and wireless remote control.

- Requires 4 x AA batteries or SV adaptor

Was $44.95

$26.95 Cat: XC-5190

SAVE $18

CLIP-ON BATTERY PACK FOR PSP

Extend the play time of your PSP with this rechargeable lithium-ion polymer battery. During play your PSP draws power from the battery pack before the PSP built-in battery.

- Matt black rubberised finish
- Includes battery bag and carry strap

Was $64.95

$39.95 Cat: XC-5198

SAVE $25

REMOTE CONTROL FOR IPOD® & IPOD® MINI

Simply plug the receiver module to your iPod® or iPod Mini® earphone jack and control the play list or slideshows up to 10 metres away.

- Remote uses 1 x CR2032 battery (included)

Was $14.95 Note: iPod® not included

$7.95 Cat: AR-3119

SAVE $7

NECK STRAP WITH EARPHONES - SUITS IPOD® NANO

Fit your iPod® Nano into this compact lightweight holster, hang it round your neck and plug-in the neatly stored headphones for true hands free action! White in colour, and compatible with iPod™ Nanos.

Was $11.95

Note: iPod® not included

$4.95 Cat: AR-2089

SAVE $7

DUAL OUTPUT VIDEO DISTRIBUTION AMPLIFIER

Ideal for video distribution applications. Features automatic gain adjustment plus twin on-board brightness and contrast controls for optimum picture quality on each output. The unit is housed in a compact ABS plastic case with an integral mounting flange.

- Requires 12VDC power
- Size 140(W) x 28(H) x 65(D)mm

Was $89

$49 Cat: QC-3438

SAVE $40

LONG RANGE VIDEO TRANSMITTER

Transmit a colour or monochrome video and data signal (RS-422 or RS-485), or an audio signal over a Cat 5 cable. 2 x 12VDC plugpacks included.

- Transmission range: Colour 1500m, B&W 2400m
- Dimensions: 70(L) x 42(W) x 45(H)mm

Was $179

$99 Cat: QC-3425

SAVE $80

All savings are based on original recommended retail prices.

Limited stock, no rainchecks

SECURITY

BUDGET 4 CHANNEL DVR WITH 4 CAMERAS

This great value DVR package is ideally suited to smaller home or office surveillance installations. It uses MJPEG video compression and can store over 150 hours of video on the installed 250GB hard drive. Recording set-up is simple and various trigger modes can be set across the day including timer, motion detection, and manual recording.

The system comes complete with:

- 4-channel DVR with 250GB HDD, USB port, and 1 x composite video output
- 4 x weather resistant colour day/night cameras
- Plug-in interconnection cables
- Remote control
- Mains adaptor and user manual

$599
Cat: QV-3063

HANDS FREE COLOUR VIDEO DOOR PHONE

You can view and talk to visitors at your door before letting them in, or you can sound an alarm to turn away unwanted guests. The CCD camera captures clear images even at night thanks to infrared illumination. You can hook up one additional monitor and camera to make a comprehensive front & back door surveillance system.

- 7" TFT screen
- AV input/output
- Mains powered
- Remote door release output
- Spare doorbell unit for QC-3616 $129

Was $449

$299
Cat: QC-3615

SAVE $150

ECONOMY 250GB MPEG-4 DVR WITH ETHERNET

SAVE $200

Amazing value! A 4-channel multiplexer and digital video recorder with Ethernet port that allows password protected remote live access and control via a web browser. Features advanced motion recording, video loss detection, remote network record and back-up support. Supplied with a 250GB HDD and can be expanded up to 400GB. See website for specifications.

- MPEG-4 compression
- 250GB HDD included
- Resolution: 352x288 pixels (CIF), 720x576 (Frame)
- Max recording frame rate: 100 IPS (CIF), 25 IPS (Frame)
- Software, power supply and manual included
- Dimensions: 343(W) x 26(H) x 223(D) mm

Was $599

$399
Cat: QV-3079

250GB HDD INCLUDED

ECONOMY 4 CHANNEL 250GB H264 DVR

Quality image reproduction at a touch of a button. A multiplexer and digital video recorder with 4 video inputs and Ethernet capability for remote access (with password protection) and control via a standard web browser. Features advanced H264 compression, VGA monitor connection, motion trigger recording, video loss detection, and USB back-up support. Fitted with a 250GB HDD. It includes software & manual disc, power supply and quick start guide.

- Resolution: 352 x 288 pixels (CIF), 704 x 576 (4CIF)
- Max recording frame rate: 100 IPS (CIF), 25 IPS (4CIF)
- Size: 343(W) x 59(H) x 223(D) mm

$599
Cat: QV-8101

NEW

Also available Economy 16 Channel 500GB MPEG-4 DVR Cat no. QV-8102 $999

GET READY FOR YOUR EASTER CAMPING TRIP

WORLD BAND AM/FM/SW RADIO RECEIVER

A great radio with an amazing list of features. It uses a phase-locked loop (PLL) for rock solid frequency stability and has AM/FM band (stereo), and three short-wave bands covering 1711kHz to 29999kHz. See website for full details.

- Local/DX switch
- I/F output
- Requires 4 x D Batteries

Was $139

SAVE $25

$114
Cat: AR-1747

1W 14 LED TORCH

Extremely bright LED torch with robust machined aluminium body. O-ring sealed for maximum protection. Requires 3 x AAA batteries.

- Dimensions: 119(L) x 33(Dia)mm

$9.95
Cat: ST-3393

NEW

ADVANCED 2W 38 CHANNEL UHF TRANSCEIVER

This advanced UHF transceiver is certainly no toy - providing a range of up to 10km line-of-sight. Save battery power by switching to the low setting (500mW) for local communications such as around the campsite. Includes a rechargeable li-ion battery and plugpack charger.

- CTCSS
- Auto squelch & roger tone
- Hi/Lo power output
- Low battery display

$99.95
Cat: QC-1047

WEATHER STATION WITH WIRELESS RF SENSOR

Have reliable local weather forecasts easily within reach with this attractive weather station. The indoor LCD display can be wall or desk mountes and features clock and calendar functions, indoor/outdoor temperature readings, humidity, barometric pressure and weather trend, includes external transmitter.

Dimensions:

- Indoor display: 110(W) x 110(H) x 37(D)mm
- External sensor: 55(W) x 83(H) x 24(D)mm

$49.95
Cat: XC-0335

RECREATIONAL SOLAR PANEL PACKAGES

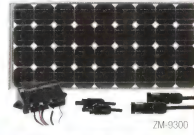
It's time to take advantage of the sun with these great recreational solar package deals! Our monocrystalline panels are by far more efficient than polycrystalline solar panels, and are strong and tough against harsh environments. Both packages come with solar regulators, & connectors - just add cable & batteries to ensure you get the most out of the sun.

Choose between these two fantastic package deals.

Package 1: 80 Watt

1 x 80W Solar Panel	ZM-9097
1 x 12V 6A Solar Charge Controller	MP-3128
2 x Female PV Connector	PS-5100
2 x Male PV Connector	PP-5102

$500
Cat: ZM-9300



ZM-9300

Package 2: 160 Watt

2 x 80W Solar Panel	ZM-9097
1 x 12V 20A Solar Charge Controller	MP-3126
3 x Female PV Connector	PS-5100
3 x Male PV Connector	PP-5102
1 x Solar Panel 'Y' Lead 2 Socket to 1 plug 300mm	PS-5110
1 x Solar Panel 'Y' Lead 2 Plug to 1 Socket 300mm	PS-5112

$1,000
Cat: ZM-9302

ZM-9302

For our full range of 5W to 175W solar panels, connectors, mounting hardware, regulators, and solar batteries see in-store or website.

Solar panel mounting hardware and batteries available separately. Check in-store or on our website.

All savings are based on original recommended retail prices.

Limited stock, no rainchecks

POWER

MAINS WIRELESS POWER MONITOR

Save on energy bills and save the environment. With the sensor unit installed in your fuse box, your household power usage data is wirelessly transmitted to the indoor display unit up to 50m away. You can also scrutinise your week-to-date and year-to-date energy consumption. LCD display and sensor unit each run on 2 x AA batteries (4 x AA batteries included).

- Display unit: 101(H) x 80(W) x 42(D)mm
- Sensor unit: 75(L) x 60(W) x 35(H)mm

$99.95 Cat: MS-6160

NEW

MAINS POWER METER

000's sold

The meter can tell you how much an appliance is costing to run and tracks the actual power being used. It can also display the instantaneous voltage or current being drawn as well as peak levels etc.

- 10A max rating.

Was $29.95

$19.95 Cat: MS-6115

SAVE $10

SEALED LEAD ACID BATTERY CHARGERS

These SLA chargers are fully automatic. When the battery's charged, the charger automatically switches to trickle charge and a green LED will show this. A red LED is lit when there is normal charging. Virtually any SLA battery can be charged but the higher the battery size, the longer the charge.

NEW

- Short circuit and wrong polarity prevention
- Will not charge a totally flat battery i.e. zero volts

Two models available:

6V **MB-3525** Was $29.95 Now $24.95 Save $5

12V **MB-3526** Was $24.95 Now $19.95 Save $5

LOW FREQUENCY SINE WAVE INVERTER -1,200W

Suited to commercial applications, this sine wave low frequency inverter uses low frequency switching with large toroid output transformers to give ultra-robust performance and surge ratings much higher than conventional switchmode inverters. This results in lower standby power, lower heating and less wasted energy from the batteries. Being a pure sine wave, you can connect any device or appliance to the output even delicate electronics & equipment with variable speed motors.

- Green Power function
- Automatic voltage regulation
- Reverse polarity protection
- Input low/high voltage protection
- Dimensions (L x W x H) 465 x 280 x 120mm
- 3m wired remote control
- Fan cooled
- Overload protection
- Low battery alarm

$1,299 Cat: MI-5180

ANSMANN BATTERY CHARGER

State-of-the-art desktop charger capable of charging up to 8 batteries at the same time. It provides super-fast charging and individual charge control for each battery.

Charges the following:

1 - 6 AAA or AA, 1 - 4 C or D, 2 x 9V

Was $119

$89 Cat: MB-3554

SAVE $30

IN-CAR AA/AAA NI-CD & NI-MH BATTERY CHARGER

Recharges 2 x AA or 2 x AAA Ni-CD or Ni-MH batteries using Delta V voltage detection which ensures the batteries are charged to their optimal levels for long life. Keep a spare set of batteries topped up and ready to go, wherever you are.

- Dimensions: 130(L) x 45(W) x 30(H)mm

Was $18.95

$10 Cat: MB-3552

SAVE $8.95

12/24V 25A SWITCHMODE BATTERY CHARGER

High tech SLA battery charger for automotive, marine, motorcycle, workshop or industrial use. Features switchmode operation, multi-stage maintenance and charging, near-bulletproof performance and microprocessor control. It is also IP rated for use in workshops & hostile environments. See website for full specifications & data sheets.

NEW

- Short circuit and reverse polarity protection
- Anti-spark protection
- Standby, fault, mode selection and charging LED indicators
- Safe to leave connected for months at a time

Dual Mod Macro

$499 Cat: MB-3606

SWITCHMODE MULTIVOLTAGE PLUGPACKS

These switchmode plugpack adaptors are slim in size, lightweight, and feature manually selectable variable voltage outputs. All are MEPS compliant and come supplied with 7 plugs and a USB output socket. (MP: 3318 does not include USB socket)

NEW

7.2W 3 - 12VDC Plugpack Cat. MP-3310 $19.95

- Dimensions: 69(L) x 39(W) x 31(H)mm

18W 3 - 12VDC Plugpack Cat. MP-3312 $24.95

- Dimensions: 69(L) x 39(W) x 31(H)mm

18W 3 - 12VDC Plugpack Cat. MP-3314 $29.95

- Dimensions: 69(L) x 39(W) x 31(H)mm

27W 3 - 12VDC Plugpack Cat. MP-3316 $34.95

- Dimensions: 96(L) x 50(W) x 30(H)mm

25W 9 - 24VDC Plugpack Cat. MP-3318 $34.95

- Dimensions: 96(L) x 50(W) x 30(H)mm

REMOTE CONTROL LIGHT WITH MAGNETIC BASE

An incredibly quick and versatile method of creating fixed light. The base features an extremely powerful set of magnets so you can fix it to a car, a metal beam, a tool box, a trailer or just about any metallic surface. Requires 6 x AAA batteries.

Was $24.95

SAVE $10

$14.95 Cat: ST-3182

LED TABLE LAMP

Quick and easy lighting solution for your bedside table, living room, study, office or caravan. Six super bright LEDs brighten any dark area or you can dim the light for a softer ambience.

- 6 LED Lights
- On/Dimmer/Off switch
- Pivoting light head
- Pivoting neck
- Requires 3 X AAA Batteries

Was $24.95

SAVE $14.95

$10 Cat: ST-3169

1.5 WATT LED TORCH

A great torch with 1.5W LED to produce a super bright output. It also has a specially designed magnifying lens to produce a more focused beam for precise illumination.

- 2.5 hour battery life
- 2 x AA batteries (included)
- Comes in nylon pouch and carry strap
- Dimensions: 173(L) x 26(Dia.)mm ***Was $59.95***

$29.95 Cat: ST-3332

SAVE $30

Also available 1000 Lumens Luxeon Torch ST-3371 Was $189 Now $149 Save $40

ADJUSTABLE LED SWIVEL LIGHT

Brighten up those dark corners in your kitchen cupboards, pantry, garage or caravan. 3 swivelling heads each with 3 LEDs and a mounting bracket for easy installation.

- One touch on/off/dimmer operation
- Requires 6 x AAA batteries
- Dimensions: 310(L) x 75(W) x 55(H)mm

Was $24.95

SAVE $10

$14.95 Cat: ST-3168

All savings are based on original recommended retail prices. Limited stock, no rainchecks

HDMI Over Cat 5 Extender

Boosts your video/audio transmission distance up to 60m (200ft) in HDTV 720p/1080i format. With two low cost Cat 5/5e/6 cables, you can extend HDTV sources from DVD players, Blu-ray Disc player, PS3, PC, and any other TMDS compliant source to distant display monitors, embedded IR receiving and emitting units.

- HDMI 1.3c compliant
- Dimensions: 80(L) x 60(W) x 25(H)mm

$199 Cat. AD-1689

HDMI In-Line Repeater/Extender

Extend the range of any HDMI device such as a monitor or TV, set-top box, DVD player, PC or gaming system up to 60 metres.

SAVE $35

- Note: Multiple extenders are required for cable runs above.
- 10m to a maximum of 60 metres.

$24.95 Cat. AC-1698

Was $59.95

IR Over Cat 5 Extender/Repeater Kit

Control AV source equipment up to a distance of 250 metres away with existing IR remote controls over Cat 5 cable. The IR remote signals are piped over the Cat 5 cable for full control at the remote location. Suitable for home theatre, lecture theatres, AV rooms, conference rooms, shop window and merchandising displays. Extender, repeater, mains plugpack and emitters included.

NEW

- Input: 1 x IR receiver, Output: 1 x Cat 5, 5 x IR extender
- Receiver frequency: 20 - 60kHz, Power supply: 5VDC, 500mA
- Dimensions: 62(L) x 50(W) x 23(H)mm

$149 Cat. AR-1826

i.Mix Club USB DJ MIDI Controller

Mix, play and scratch your own MP3 tracks directly from your PC. The i.Mix gives you the control you love when going from a traditional mixer to a laptop. It sends MIDI data from the controller to your DJ software without the inconvenience of mouse control. Complete with LE versions of Deckadance and Traktor 3 software. This is the ultimate tool for the performing DJ.

SAVE $50

- 2 deck controller
- Mix 2 tiles in 1 controller
- USB powered, no extra power needed
- Totally portable, smaller & lighter than a laptop
- 2 pro jog wheels
- Pitch, search and scratch
- 3 faders: 1 cross fade, 1 volume per deck
- 6 EQ filters with 6 kills

$299 Cat. AM-4259

System requirements:
- Windows XP SP2 or Vista
- Pentium III or Athlon 1GHz
- 512MB RAM
- Dimensions: 360(W) x 202(H) x 45(D)mm

Was $349

Compact USB Media Player and Controller

A USB compatible digital music controller that has the power to cue, play, manipulate and even scratch digital files. Add some FX in real time, plug and play your MP3s within any booting or searching time. It supports external USB mass storage devices up to 80GB.
See our website for full specifications.

- DSP effects
- Multi function JOG mode
- VBR & CBR file support
- Ultra-fast instant start cue
- Dimensions: 204(W) x 215(H) x 93(D)mm

SAVE $50

$349 Cat. AI-0499

Was $399

Also available:

8 Channel Compact Mixing Console with Digital Effects	Cat. AM-4204	$299
i.Scratch CD & MP3 DJ Station	Cat. AA-0493	$349
Rack-Mount Dual DJ CD Player	Cat. AA-0491	$349

During March select from one of these items and receive a DJ Single Headphone with Handle Cat. AA-2059 valued at $34.95 absolutely FREE!

Battery Powered 2.4GHz AV Sender

Wireless and compact, this is the ideal solution when power availability and space are a consideration. Both transmitter and receiver operate on battery power. Connection to the AV source is via 3.5mm to RCA composite video and audio lead.

SAVE $53

- 2 x 1m leads included
- Each unit requires 2 x AA batteries
- 85mm wide

$26.95 Cat. AR-1852

Was $79.95

VHF UHF Indoor TV Antenna Amplifier

This indoor TV antenna includes an amplifier. The amplifier has 24dB gain on VHF and 20dB gain on UHF as well as a gain control. It operates directly from the 240V mains power supply, so no extra plugpack is required. There is an auxiliary input socket also, for connecting a TV game, or any other device.

Frequency: 40-862MHz
Noise Figure: 5dB
Size: 240(W)x165(D)mm

$39.95 Cat. LT-3135

SAVE $10

Was $49.95

Digital Indoor/Outdoor Antenna

With its contemporary style design it will provide you with the high quality clear reception needed. The panel can be mounted to the wall, great for minimising space. AC adaptor included.

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10dB antenna gain, 40dB total gain
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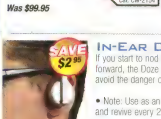

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This water resistant, metal bodied, CMOS camera is flush mounted and has inserts to allow for angled applications such as a car rear vision camera.

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This is limited time only so hurry before they are gone! Features 5 watt UHF CB with 38 channels, dual watch, LCD display for channel, time, menu, and other modes, and more!

This will keep you clearly in touch with the kids at up to 3km range, and feature the build quality of more expensive units. Perfect for camping, picnics in the bush, skiing and hiking trips.

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PRODUCT SHOWCASE

Altronics USB MP3 Audio Player: so simple!

If you have a need to add music to any audio system – background music, for example, or even home music systems – and don't want to continually do the CD shuffle, here's a great little MP3 Audio Player from Altronics.

All you do is copy the music required (in MP3 format) onto any USB storage, such as a flash drive as shown here (or if you want months of music, a USB hard drive!), plug it in, connect to a line level input, connect 12VDC and and press play.

It has its own level control and with just three push-button switches (previous track, next track and play/pause) it could hardly be simpler to control.

If you don't physically stop it, tracks will loop giving virtually unlimited length of playback,

Apart from the fact that it just works, it's housed in a rugged metal case so it will take the rough-and-tumble of a roadie's goody bag.

We tried it out for surf carnival music and were very impressed. The quality of reproduction is very good indeed (well, as good as MP3s and an outside PA system will allow!).

It's available from all Altronics stores, most dealers and through the Altronics website for $89.95 (Cat No A2710).

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PO Box 8350, Perth Busn Centre, WA 6849
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Thermometer Probes offer -200° to 450° range

Two new full- immersion platinum resistance thermometer (PRT) probes from Hart Scientific (a division of Fluke) are designed to perform in extreme environments.

The 5606 probe has a temperature range of -200°C to 160°C, while the 5607 has a range of 0°C to 450°C. Probes, lead wires and junctions withstand the entire temperature range.

They are designed to perform in "full immersion" applications where both the transition junction and the lead wires must withstand temperatures covering the entire operating range of the probe. Such applications can include calibration or validation of sensors used in laboratory or bio freezers, walk-in refrigerators, autoclaves, ovens, stability test chambers, furnaces or incubators.

Contact:
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Electronics Workbench with the lot!

Industrial ergonomics specialist, Actisafe, has developed a Electronics Workbench which can be customised specifically for the end user.

They identified a need for a more specialised product for electronics technicians after seeing that very little was available in this specific sector of industry.

Each Actisafe Electronics Workbench can be fitted out with wiring, sockets and other power related facilities according to specific use.

It can also be completely fitted out with an antistatic configuration for sensitive assembly or repair applications.

Made from industrial grade steel, the Electronics Workbench is powder coated to withstand any potential for rust and to be able to take all the knocks and bumps to which such equipment is often exposed. Dimensions can be according to requirements and as many drawers as are needed can be factored into the design.

The workspace for the technician has ample facilities and all tools and components can be neatly arranged on holders – off the workspace – and in within immediate reach.

Actisafe manufactures its Electronic Workbench in a range of colours; however, in certain quantities customers can also request the equipment be finished in a specific colour to match its corporate identity.

Contact:
Actisafe
Tel: 1300 852 397 Fax: 1300 882 529
Website: www.actisafe.com.au

BIGAVR6 now available

The new BIGAVR6 Development System from mikroElektronika supports 64 and 100-pin AVR (TQFP package) and gives designers an easy-to-use platform to try a multitude of designs.

BIGAVR6 includes new features such as CAN Module, Serial EEPROM, RTC and many more. Each feature is supported by examples written in mikroC PRO, mikroPascal PRO and mikroBasic PRO compiler for AVR. BIGAVR6 comes with full color printed documentation.

The system price is $139.00 USD and it can be purchases via the mikroElektronika website and through authorised distributors.

For more information on the BIGAVR6 Development System, visit the mikroElektronika website: www.mikroe.com

By NICHOLAS VINEN

A High-Quality Digital Audio Signal Generator; Pt.1

This Digital Audio Signal Generator has TOSLINK and coax (S/PDIF) digital outputs, as well as two analog audio outputs. If a digital output is used, the harmonic distortion from a high quality DAC is extremely low. Alternatively, if you use the analog outputs the harmonic distortion of the sinewave signal is typically still very low at less than .06%.

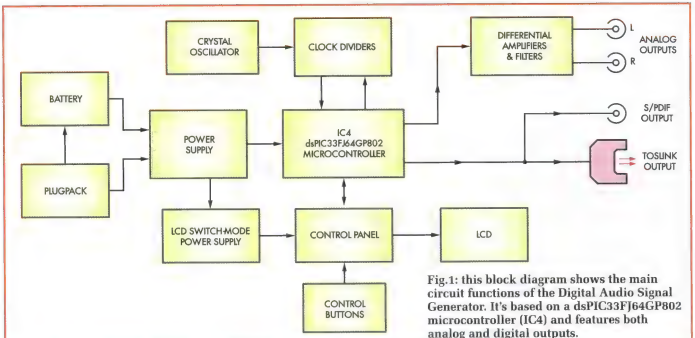


Fig.1: this block diagram shows the main circuit functions of the Digital Audio Signal Generator. It's based on a dsPIC33FJ64GP802 microcontroller (IC4) and features both analog and digital outputs.

AS WELL AS SINEWAVE outputs with low distortion, this Digital Audio Signal Generator produces a range of other waveforms which you would normally obtain from a high-quality function generator. These waveforms include square, triangle and sawtooth etc, as well as advanced functions that include waveform mixing, pulse and sweep modes.

If you connect the SPDIF digital output to our high-quality Stereo Digital-to-Analog Converter (DAC), (SILICON CHIP, September-November 2009), you get a sinewave output with very low distortion in the audio band. We measured around 0.0006% THD+N (20Hz-22kHz bandwidth) for a 1kHz full-scale sinewave with a sampling rate of 48kHz and less than 0.001% THD+N for any frequency between 20Hz and 2kHz.

The distortion is less than 0.006% up to 20kHz (or 0.005% with a sampling rate of 96kHz). That is lower distortion than from any commercial audio generator that we know of.

There is one important proviso. Using a DAC for signal generation means that there will be high-frequency switching noise in the output. This is true whether you use an external DAC or the internal one which drives the analog outputs.

Usually, this will not be an issue, however it is important to keep it in mind. If you use the signal as part of a noise or distortion test, the measuring equipment will need to be able to ignore residuals above 20kHz.

S/PDIF Audio Generator: Main Features

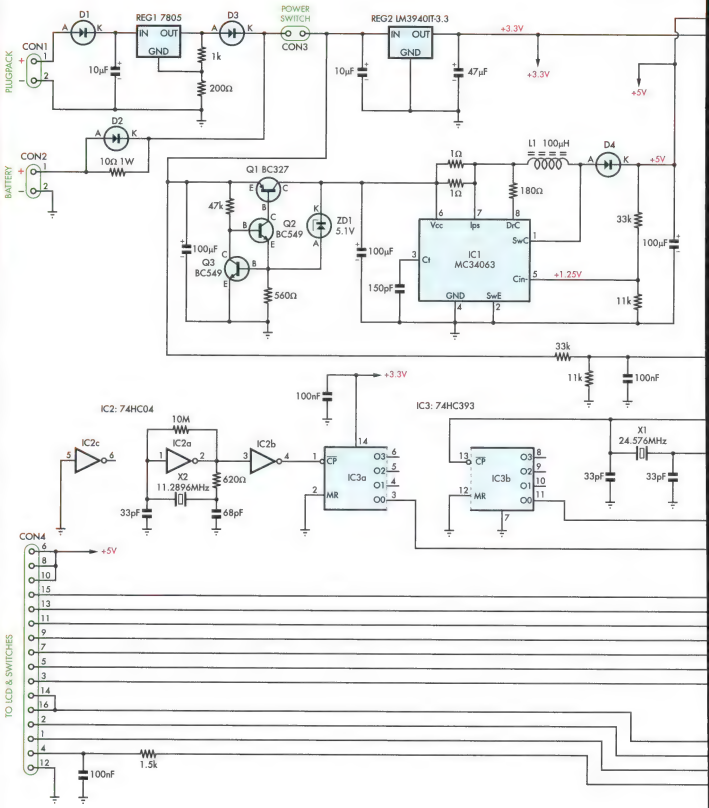
- Five waveform types supported: sine, square, triangle and two sawtooth
- Frequency range: 1Hz - 24kHz in 1Hz steps at 48kHz sampling rate or 1Hz - 48kHz at 96kHz sampling rate (see text)
- Five waveform generation modes and four output modes (see Tables 1 & 2)
- Runs off a plugpack (9-10V DC) or a battery (4 × AA or AAA cells).
- Built-in battery voltage monitor with settable low battery voltage warning
- Status display for pulse and sweep modes, to show amplitude and frequency
- Sweep can be manually triggered or paused/resumed/restarted
- Digital output can be switched between "consumer" (S/PDIF, 20-bit data) and "professional" (AES/EBU, 24-bit data) modes
- Can enable pre-emphasis bit on digital output if desired
- 10 setting banks for storing modes and configuration
- Digital LCD contrast and backlight brightness control

Features

Five waveform types are supported: sine, square, triangle and sawtooth up/down. Both analog channels always produce the same waveform, although the frequencies and amplitudes are independently adjustable. In certain modes, frequency or amplitude are fixed between the two channels but they can always be individually muted.

The available frequency range is 1Hz - 24kHz in 1Hz steps at the default sampling rate of 48kHz. You can increase the sampling rate to 96kHz and the upper frequency limit is then 48kHz. If you set the sampling rate to the third option, 44.1kHz, the upper frequency limit is 22.05kHz. These are the Nyquist frequencies – the highest frequency that can be digitally represented at that sampling rate.

Frequency accuracy and stability is limited by the crystals, so it should generally be within 50 parts per mil-



S/PDIF & TOSLINK DIGITAL AUDIO SIGNAL GENERATOR

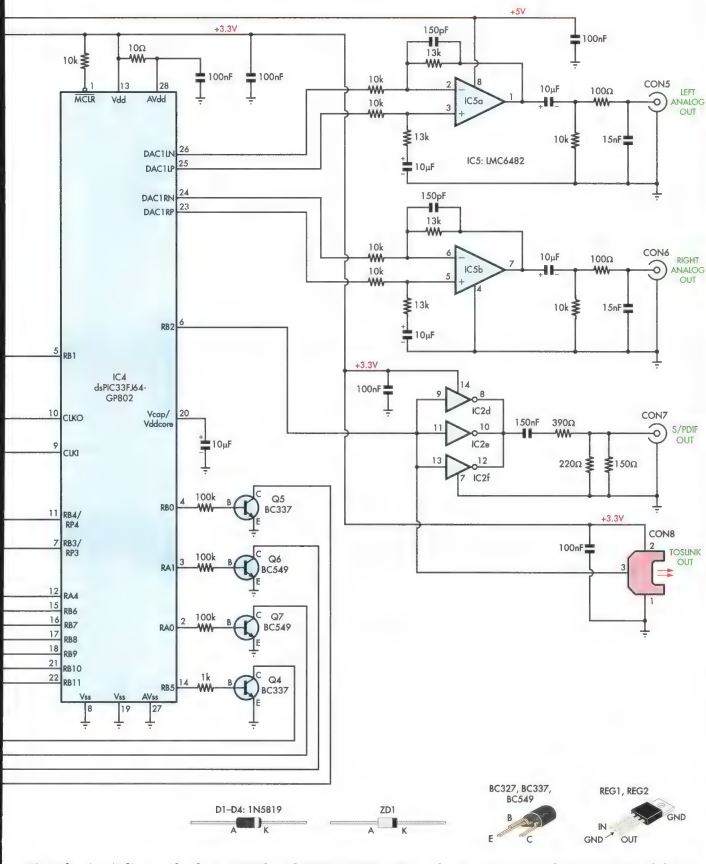


Fig.2: the circuit diagram for the main PC board. REG1, REG2 & IC1 are the main power supply components, while IC2 & IC3 generate the clock signals. IC4 performs the signal generation and also interfaces to the LCD board. Pins 23-26 drive op amps IC5a & IC5b to produce the analog signals, while pin 6 drives the TOSLINK & S/PDIF outputs.

Table 1: Waveform Generation Modes

Mode	Features
Locked	Single frequency, adjustable phase difference between the left & right channels
Independent	Different frequencies can be output on the left and right channels
Mixed	Mixes signals of two different frequencies & amplitudes, output on both channels
Pulsed	Amplitude alternates between two values with configurable on/off delays
Sweep	Frequency varies over time, ramping up or down over a specified time period

Table 2: Output Modes

Sampling Rate	Outputs Enabled	Comment
44.1kHz	Digital (S/PDIF) only	CD quality
48.0kHz	Digital (S/PDIF) and Analog	DVD quality
96.0kHz	Digital (S/PDIF) only	DVD-audio, etc
96.0kHz	Analog only	Highest quality analog

lions (ppm) or 0.005% at 25°C – a typical crystal frequency tolerance. Over a wider range of temperatures, the drift might be up to 100 ppm (0.01%). This translates to an actual 1kHz frequency of between 999.9Hz and 1000.1Hz. We measured 999.95Hz from our prototype.

The output amplitude ranges from 0dB to -98dB in 1dB steps, as well as an "off" setting in place of -99dB. Amplitude accuracy is good, with a -90dB 1kHz sinewave actually being measured as -89.37dB using our Audio Precision System One. If you use the analog outputs, the 0dB amplitude level is close to 1V RMS. Alternatively if you use the recommended external DAC, 0dB translates to around 2V RMS, with much lower distortion.

Waveform generation modes

There are five main waveform generation modes to choose from (see Table 1) and four output modes (see Table 2). Taken together, the waveform type, waveform generation and output modes make for a total of 100 different mode combinations. Any generation mode can be combined with any waveform type, although you can't have different waveform types on each channel.

Table 4 gives specific information on each waveform generation mode.

Circuit details

The general details of the unit are shown in the block diagram of Fig.1. As is usual with a project of this complexity, it is based on a high performance microcontroller, IC4. This generates the digital and analog output signals, in response to commands from the control panel pushbuttons. It also drives the LCD panel. Note that there are two digital outputs: TOSLINK and S/PDIF coaxial.

Applications

- RMS and music power testing for power amplifiers
- Speaker placement optimisation
- Sub-woofer or speaker crossover optimisation
- Finding faults in audio equipment
- Audio quality testing for analog or digital audio equipment with appropriate measurement equipment (THD, SNR, channel separation, intermodulation distortion, frequency response, etc)
- Analog circuit prototyping and development
- Testing DACs or other equipment that accept a digital audio signal
- Whenever you need an adjustable audio-frequency signal source.

Turning to the full circuit in Fig.2, IC4 can be seen to be a dsPIC33FJ64GP802 16-bit Digital Signal Controller. This microcontroller runs at up to 40MHz and has 64KB of flash program/data memory and 16KB of Random Access Memory (RAM).

Because it's a 16-bit processor, it can manipulate much larger numbers than an 8-bit microcontroller, improving its efficiency in dealing with audio data. Its Data Converter Interface (DCI), internal Digital-to-Analog Converter (DAC) and Direct Memory Access (DMA) support are all especially useful for this project.

The dsPIC33 runs off 3.3V which is provided by an LM3940IT-3.3 low drop-out linear regulator (REG2). This ensures that the microcontroller can run with cells developing as little as 0.9V each (3.6V total), by which time most of the energy has been extracted from them. You shouldn't drain NiMH cells this low but it's OK with alkaline or dry cells.

The rest of the power supply is a little more involved. We need 5V for the LCD and its backlight. Because the battery voltage could be above 5V (with NiMH cells being charged or fresh primary cells) or below 5V (NiMH cells being discharged or flat primary cells), the LCD supply needs to be able to increase or decrease its input voltage. We deliberately kept it simple by combining a discrete low drop-out linear regulator with a switchmode boost regulator. This keeps size and cost down and uses readily available parts while retaining reasonable efficiency.

The discrete linear regulator consists of three transistors (Q1-Q3), zener diode ZD1 and two resistors. While it does not have particularly good load regulation its dropout is very low (around 0.1V) which means that when the battery voltage is below 5V it doesn't waste much power. It is followed by the boost regulator which is built around IC1, an MC34063 switchmode DC-DC converter. It switches power through the inductor at around 100kHz, keeping the output at 5V.

This ensures that the LCD continues running as long as the microcontroller does. It also keeps the LCD backlight brightness and contrast constant as the cells discharge.

The 7805 regulator (REG1) is mainly there to protect the LM3940IT-3.3 from voltages above its maximum rating

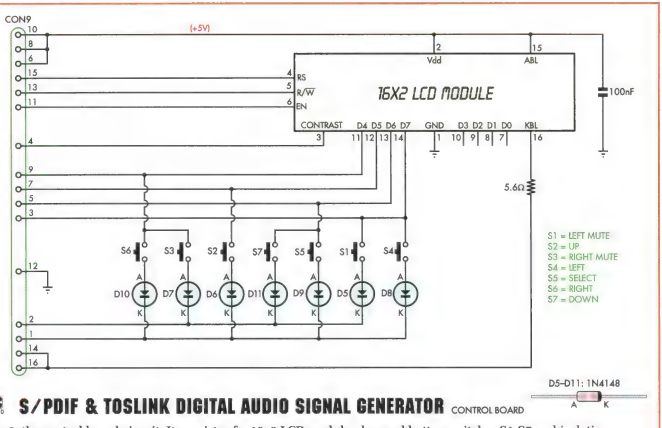


Fig.3: the control board circuit. It consists of a 16x2 LCD module plus pushbutton switches S1-S7 and isolating diodes D5-D11. The microcontroller (IC4) on the main board reads the switch states and updates the display.

(7.5V). The 1kΩ & 200Ω resistors associated with REG1 are used to increase its output to around 6.8V, ensuring that it always exceeds the battery voltage. That way, the battery can't be drained when the plugpack is connected and it also allows rechargeable cells to be kept charged reasonably well.

Clock generators

There are two oscillators to produce the three sampling clocks. One runs at 11.2896MHz (44.1kHz × 256), while the other runs at 24.576MHz (96kHz × 256). The 48kHz rate is generated within the microcontroller by halving the 96kHz clock.

While the 11.2896MHz crystal has its own oscillator circuit (driven by IC2a, one section of a 74HC04 hex inverter), the 24.576MHz crystal uses the dsPIC33's internal oscillator amplifier. It has a dual purpose – to generate the clock for 96kHz sampling and also to provide the dsPIC's system clock.

Fortunately, it's easy to configure the dsPIC's internal PLL to derive 39.936MHz from the 24.576MHz crystal, which is close enough to its 40MHz operating limit. As a result, the microcontroller is able to shut down the 24.576MHz oscillator if the battery is flat to save some power.

The 74HC393 ripple counter, IC3, has two purposes. First, it divides the oscillator frequencies to the S/PDIF encoding clock frequency we need, 5.6448MHz & 12.288MHz, which is 128 times the sampling rate in each case. Second, it ensures that the clocks have a 50% duty cycle.

Digital outputs

The digital audio signal is fed to both TOSLINK (optical) and coaxial outputs. For the optical output, the signal from the microcontroller's Data Converter Interface (DCI) is sent directly to the TOSLINK transmitter (CON8). For coaxial, we use three inverters from IC2, connecting them in parallel to buffer the signal which is then coupled via the 150nF capacitor and fed to a resistive divider to produce the correct voltage and impedance levels for S/PDIF signals.

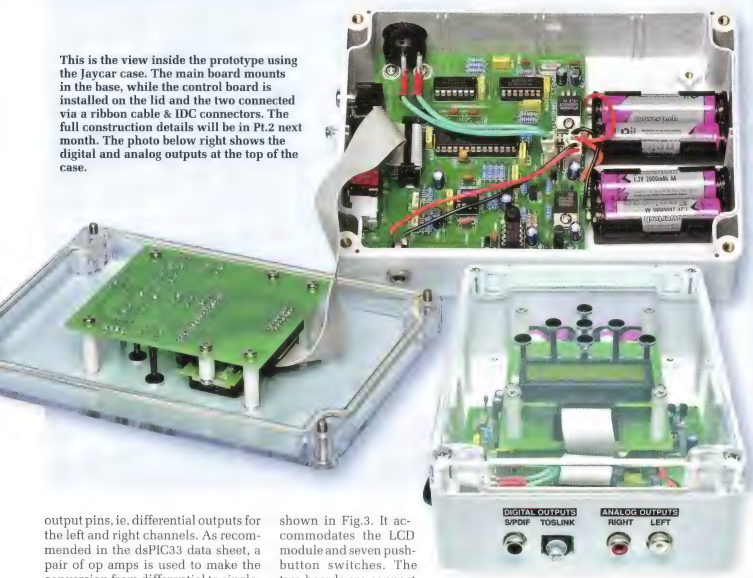
Analog outputs

The dsPIC's internal DAC is a Delta-Sigma type. It's much like the SILICON CHIP Stereo DAC but has inferior audio quality. Its residual switching noise is fairly high and is at 12.288MHz or 24.576MHz, depending upon the sampling rate.

The dsPIC33 actually has four DAC

Table 3: Performance

Measurement @ 1kHz, SR = 48kHz, BW = 20Hz-20kHz	Internal DAC	External DAC
THD+N	0.06%	0.0006%
Signal-to-Noise Ratio	-66dB	-111dB
Channel Separation	-66dB	-107dB
Attenuation at 20Hz	-0.07dB	-0.013dB
Attenuation at 20kHz	-0.67dB	-0.177dB
Attenuation at 40kHz (SR = 96kHz)	-1.6dB	-2.4dB



This is the view inside the prototype using the Jaycar case. The main board mounts in the base, while the control board is installed on the lid and the two connected via a ribbon cable & IDC connectors. The full construction details will be in Pt.2 next month. The photo below right shows the digital and analog outputs at the top of the case.

output pins, ie, differential outputs for the left and right channels. As recommended in the dsPIC33 data sheet, a pair of op amps is used to make the conversion from differential to single-ended outputs. In fact, we have used an LMC6482, a dual CMOS rail-to-rail amplifier (IC5), for this task to get the best signal quality from the limited supply rail of only 5V.

In order to remove most of the high-frequency switching noise, we have added two filter stages to the differential amplifier stages of IC5. The first is the active filter in the op amp feedback networks, comprising the 150pF capacitors and 13kΩ resistors. The second filter involves the passive filters (100Ω and 15nF capacitor) after the 10µF output capacitors and just before the output connectors (two RCA sockets).

Control panel

All the components mentioned thus far are mounted on the main PC board. It is connected to the control panel PC board via CON3, shown at the lefthand side of Fig.2.

The circuit of the control board is shown in Fig.3. It accommodates the LCD module and seven push-button switches. The two boards are connected via a 16-wire ribbon cable with IDC headers, ie, from CON3 on Fig.2 to CON9 on Fig.3.

The LCD's backlight brightness and contrast are regulated by the microcontroller. The brightness is adjusted via an NPN transistor (Q4) which is pulse-width modulated at 50kHz; increasing the duty cycle increases the brightness.

This not only allows you to adjust it as desired (via the relevant push-button) but also saves battery usage because only a low-value (5.6Ω) current limiting resistor is required. The default 25% duty cycle allows the LCD to be viewed under virtually any lighting condition without being too much of a drain on the battery.

The contrast control is a little more tricky, since we need a variable current sink to adjust it properly. This too is achieved via a 50kHz PWM signal from pin 4 of IC4 to the base of NPN transistor Q5 which pulls current from the LCD display through a 1.5kΩ resistor. If the resistor is switched on by Q5 for, say, 50% of the time, this makes the circuit roughly equivalent to a 3.0kΩ resistor. A 100nF MKT capacitor filters this switching to provide a variable supply to the LCD between its V_{CC} and V_O pins.

Button multiplexing

While 28 pins on a microcontroller may seem like a lot, in reality it was difficult to wire up everything needed for this project. Of the 28 pins, nine are dedicated to power supply, the main oscillator or reset functions, leaving 17 general-purpose pins. After subtracting the signal generator and battery monitoring functions, we're left with only nine for both LCD communications and button sensing for the user interface.

Communicating with the LCD without additional components requires at least seven pins, four for data I/O and

Parts List

1 IP67 polycarbonate enclosure with transparent lid, 171 × 121 × 55mm (Jaycar HB-6218) or 186 x 146 x 75mm (Altronics H-0330)
2 16-pin IDC crimp connectors
1 4AA side-by-side battery holder with leads (or 2 × 2AA side-by-side battery holders)
1 SPST rocker switch (Jaycar SK0960, Altronics S3188) or miniature/sub-miniature toggle switch
2 4.8mm female spade crimp connectors (only if SK0960/S3188 switch or similar is used)
1 2.1mm bulkhead male DC power connector (Jaycar PS-0522, Altronics P-0622)
1 300mm length of 16-way ribbon cable
1 300mm length of double-sided tape
1 300mm length of red medium duty hook-up wire
1 300mm length of black medium duty hook-up wire
Optional: 4 x low self-discharge AA 2000mAh NiMH cells (Jaycar SB1750, Altronics S4705 × 2)
Optional: 9V 500mA DC regulated plugpack or 7.5V 500mA DC unregulated plugpack, with 2.1mm ID plug (nominal output 9.5V @ 250mA, acceptable range 9-11V)

Main Board

1 PC board, code 04203101, 109 × 102mm
1 100µH bobbin inductor with 2.54mm pin spacing (Jaycar LF-1102) or 1 x 100µH axial inductor (Altronics L7034)
1 PC-mount RCA connector (black)
1 PC-mount RCA connector (white)
1 PC-mount RCA connector (red)
1 16-pin IDC socket
3 2-pin polarised headers
3 2-pin polarised header connectors
1 2-pin shorting block
6 M3 x 6mm machine screws (or 2 if Altronics H-0330 box is used)
2 M3 nuts
2 M3 flat washers
2 M3 star washers
1 PC-mount TOSLINK transmitter (Jaycar ZL-3000, Altronics Z-1601)
1 28-pin narrow machine-tooled IC socket
2 14-pin machine-tooled IC sockets
2 8-pin machine-tooled IC sockets

Semiconductors

1 MC34063 switchmode DC-DC converter (IC1)
1 74HC04 hex inverter (IC2)
1 74HC393 dual 4-stage ripple counter (IC3)
1 Microchip dsPIC33FJ64GP802 microcontroller programmed with 0420310A.hex (IC4)
1 LMC6482 dual op amp (IC5)
1 BC327 transistor (Q1)
2 BC337 transistors (Q4,Q5)
4 BC549 transistors (Q2,Q3, Q6,Q7)
1 LM7805T 5V regulator (REG1)
1 LM3940IT-3.3 or TS2940CZ-3.3 3.3V regulator (REG2)
4 1N5819 Schottky diodes (D1-D4)
1 5.1V 1W zener diode (ZD1)

Crystals

1 24.576MHz crystal (HC-49, low profile if possible)
1 11.2896MHz crystal (HC-49, low profile if possible)

Capacitors

3 100µF 16V electrolytic
1 47µF 16V electrolytic
6 10µF 16V electrolytic
1 10µF 16V tantalum
1 150nF MKT polyester or polycarbonate
8 100nF MKT polyester or polycarbonate
2 15nF MKT polyester or polycarbonate
3 150pF ceramic
1 68pF ceramic
3 33pF ceramic

Resistors (0.25W, 1%)

1 10MΩ	1 390Ω
3 100kΩ	1 220Ω
1 47kΩ	1 200Ω
2 33kΩ	1 180Ω
4 13kΩ	1 150Ω
2 11kΩ	2 100Ω
7 10kΩ	1 10Ω
1 1.5kΩ	1 10Ω 1W
2 1kΩ	2 1Ω 0.6W 5%
1 620Ω	7 0Ω (or wire links)
1 560Ω	

Control Board

1 PC board, code 04203102, 87 x 73mm
7 1N4148 diodes (D5-D11)
1 100nF MKT polyester capacitor
1 5.6Ω resistor
1 0Ω resistor (or wire link)
1 16-character x 2-line alpha-numeric LCD with backlight (Jaycar QP-5512; Altronics Z-7013)
7 tactile pushbutton switches with long actuators (Altronics S1119)
7 button caps (Altronics S-1482)
1 16-pin IDC socket
1 16-pin single row female header
1 16-pin single row male header
6 M3 x 9mm tapped Nylon spacers
4 M3 x 12mm tapped Nylon spacers
4 M3 x 6mm machine screws
4 M3 x 10mm countersunk machine screws
4 M3 x 15mm machine screws
2 M3 nuts
Note: for Altronics box replace the 12mm spacers with 9mm spacers, delete the M3 nuts and add 8 x M3 star washers

three for control. Fortunately, there is a way to connect the seven buttons using the two remaining pins, by time-multiplexing the LCD I/O lines.

When there is no communication occurring with the LCD, its I/O lines are unused and are high impedance. So, we connect these four pins to one end of each of the seven buttons (six sharing three lines between them). The other side of each button is connected via 1N4148 diodes to two NPN transistors, Q6 & Q7; the diodes are on Fig.3 while the transistors are on Fig.2.

When those two transistors are

Fig.4: this the default Locked Mode display. The unit generates a 1kHz sinewave signal with a 180° phase difference between the two channels.

Fig.5: this is the default Sweep Mode display. Both channels output a sinewave which starts at 20Hz and ramps up to 20kHz over a 10s period.

Fig.6: the default Pulsed Mode display. Both channels alternate between 0dB and -30dB amplitude each second (100ms high; 900ms low).

Fig.7: the output/wave type setting display. In this case, the sampling rate is 48kHz and a sinewave is being generated.

switched off by the microcontroller, the diodes ensure that they do not affect the LCD I/O lines, regardless of whether any of the buttons are pressed. However, we can sense the button state when those transistors are turned on (one at a time) while we simultaneously enable the pull-up resistors on the four LCD I/O lines, pins 17, 18, 21 & 21 of IC4.

In this state, any button that is pressed will pull its corresponding I/O line low if its associated transistor is actively sinking current. Thus we can periodically scan the buttons without affecting the LCD.

Battery charging

As mentioned, Nickel Metal Hydride (NiMH) rechargeable cells can be used to power the unit and you can add a 10Ω 1W resistor to trickle charge them whenever the plugpack is connected. We've provided an appropriate mounting point on the PC board.

The final trickle charge current for an NiMH cell varies somewhat but is typically between C/10 and C/40, ie 1/10th to 1/40th of its rated amp-hour capacity. We've set the resistor so that it provides a little under 100mA to the cells once they are fully charged, which equates to a rate of C/20 for 2000mAh cells. Keep in mind that the charge current will be appreciably higher than this when the cells are flat, as it decreases during charging.

If you use cells with a lower capacity than 2000mAh then you need to increase the value of the resistor accordingly. For example, 800mAh cells would require a 27Ω 1W resistor rather than the 10Ω resistor specified. For 600mAh cells, you would use 33Ω. We don't recommend you exceed C/20 for any NiMH cells.

Trickle charging is a lot slower than removing the cells and charging them properly but it is more convenient. This is especially true if you will generally run the signal generator off mains power with occasional battery use in-between. This way, the battery will always be ready for those times you need to take it into the field or are away from a convenient power point. It also saves you the hassle of having to unscrew the lid to gain access to them.

Heat dissipation in the resistor will be kept under its 1W rating as long as the battery never goes below 3.6V. It's not a good idea to discharge NiMH cells to that extent anyway. If you do apply DC power with a battery below 3.6V, its voltage should rise rapidly and reduce the charge current to the safe range but the best option in that case would be to remove the cells and re-install them once they have been properly charged.

If you install this resistor, you can only use NiMH or Nicad cells in the device. If you will ever use alkaline or dry cells, do not install it or they might overheat and leak if you accidentally plug it into DC power.

Software details

The software development for this project was complicated by the number of modes and features and because all the modes have to run in real time up to the maximum 96kHz sampling rate. We were able to pack it all into the 64KB of flash memory – but only just.

The software consists of a number of modules:

- LCD display routines
- Button sensing & repeat logic
- Interface code – determines what to display on the LCD and how to react to button presses
- Digital & Analog output control
- Waveform generation (sine table lookup, linear interpolation, other waveform calculations)
- Output amplitude scaling
- Waveform generation modes (mixed, sweep, pulsed, etc)
- S/PDIF encoding
- Direct Memory Access (DMA) Interrupt Servicing
- Communication between the interface code and the waveform generator
- EEPROM emulation for storing settings in flash memory (provided by Microchip)
- Battery monitoring & power saving

The interface code runs in the main loop, while all the waveform generation happens asynchronously in the DMA Interrupt Service Routine (ISR). This way, the time-critical waveform generation has absolute priority. If it did not provide the output data within a certain amount of time in all cases, the waveforms would be subject to glitches. In practice, this scheme works well because even though the interface only has a small percentage of the CPU time remaining to run, it is not an intensive task so the delay is not noticeable.

What ties it all together is the communication code that passes data from the interface to the ISR. It is implemented so that changes in the output are as seamless as possible.

Simultaneous analog and digital output is only available at the 48kHz sampling rate. This is because at 96kHz we only have half as much time to generate the waveform data and it's simply too slow to output both sets of data. We can't enable the analog outputs at 44.1kHz either because the DAC clock input is less flexible than the DCI's.

Real-time processing

With the microcontroller running at 40MHz and outputting audio data at 96kHz, we only have 40M/96k = 416 processor cycles to generate and output each data point for both channels. This may sound like plenty of cycles but there is much to do in that time. The steps set out in Table 5 must occur for each set of four samples that are output (experimentally determined to be the optimal number).

Because this all has to be executed in

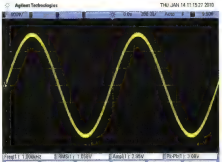


Fig.8: this screen grab shows a 1kHz sinewave from one of the analog outputs.

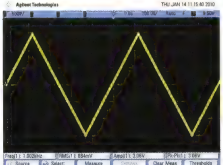


Fig.9: this is the 1kHz triangle wave output from one of the analog outputs.

under 416 cycles per sample under all circumstances (in reality slightly less), it became obvious that we needed to specialise the ISR routines for certain modes.

The final version of the software has 31 different ISR subroutines. Each one covers some subset of the 100 possible mode combinations. Some handle a single mode, others several.

The more complex the mode combination, the more specialised the ISR must be to run fast enough. It's a balancing act between having few enough routines to fit in flash memory but specialising them sufficiently to run fast enough.

As an example of a mode-specific ISR, there is one specifically to handle a high to low frequency geometric sweep with a sinewave format at the 48kHz sampling rate. Whenever you change the mode, the code determines which handler is appropriate and installs it.

Sinewave generation is the slowest of all the waveforms. Because it takes too long to calculate the sine values from first principles, we use a 6000 entry quarter-sine table stored in the flash memory. This takes up approximately 18KB of the available 64KB.

Table 4: Waveform Generation Mode Details

Locked Mode

Options: Frequency (Hz), phase difference between channels (0-360°), left channel amplitude, right channel amplitude.

Output: Each channel generates a waveform of the same type and frequency, with independent amplitudes. The phase difference between the channels is maintained at the specified number of degrees.

Uses: As well as general signal generation duty, especially when you want both channels to provide identical signals (ie, set phase difference to 0°), this could be used (for example) to test the power delivery capability of a bridged stereo amplifier, by feeding the same sine waveform to its two inputs 180° out of phase.

Independent Mode

Options: Left channel frequency (Hz), right channel frequency (Hz), left channel amplitude, right channel amplitude.

Output: Each channel generates a waveform of the same type, with independent amplitudes and frequencies. There is no fixed phase relationship between the channels, although if one frequency is an integer multiple of the other the generator will attempt to keep them in phase (eg, 1kHz & 2kHz).

Uses: Could be used, for example, to measure high-frequency feed-through between channels or as two independent simple signal generators.

Mixed Mode

Options: Frequency A (Hz), frequency B (Hz), amplitude A, amplitude B.

Output: Both channels generate the same waveform, although they can be independently muted. The output consists of the average of the two waves specified. There is no fixed phase relationship between the waves, although if one frequency is an integer multiple of the other the generator will attempt to keep them in phase. Because they are averaged, the maximum amplitude of either of the two waves is effectively half that as in the other modes.

Uses: Could be used to measure intermodulation distortion with the correct analysis equipment (eg, FFT analyser) or alternatively, used when you need a repetitive waveform with some harmonics.

Pulsed Mode

Options: Frequency (Hz), on amplitude, off amplitude, on time (0-999ms), off time (0-9999ms).

Output: Both channels generate the same signal but can be independently muted. The output consists of the specified waveform and frequency, with a varying amplitude. The scale is set to the "on amplitude" for the period of "on time", then it changes to the "off amplitude" for the period of "off time". This process repeats forever. Both amplitude changes occur on the first available zero crossing to prevent glitches in the output unless the frequency is so low as to make it impractical (<500Hz, lower in some modes).

Uses: Primarily to measure "headroom" or "music power" of an amplifier but there are other situations where a pulsed waveform may be useful.

Sweep Mode

Options: Start frequency (Hz), finish frequency (Hz), sweep time (0-99.9s), off time (0-99s), amplitude.

Output: Both channels generate the same signal, although they can be independently muted. The signal consists of the specified waveform and amplitude, with the frequency sweeping between the specified start and end points. If the start frequency is set lower than the finish frequency then it will sweep up, otherwise it will sweep down. By default, the sweep rate is exponential, which means that the time it takes for the frequency to double (or halve) is consistent. However, if for some reason you want the sweep to have a constant rate of frequency change (in Hz) you can enable the "linear sweep" mode.

Uses: Frequency response measurements for analog equipment and speakers, speaker crossover and placement optimisation and sub-woofer matching.

Table 5: Real-Time Processing Steps

(1) Enter ISR
(2) Save register context
(3) For each of the four samples:
  (a) Calculate the next waveform point value;
  (b) Scale it to the appropriate amplitude;
  (c) If mixing, calculate the other waveforms and average them;
  (d) If outputting S/PDIF, perform S/PDIF bitstream encoding;
  (e) If analog outputs are active, place sampling value in DAC buffer;
  (f) Update the waveform position;
  (g) Determine whether we are in a special mode (pulsed or sweep);
  (h) Adjust amplitudes/frequencies over time as necessary;
  (i) Write to DMA buffer.
(4) Clear interrupt flag
(5) Restore register context
(6) Leave ISR

Normally, tables stored in flash on a dsPIC device take up 50% greater space than you would expect because of the way it packs 16-bit data words into the 24-bit flash. However, we came up with a way to use all 24 bits of each instruction word to store the sine table data.

The possibility of packed flash storage for data is mentioned in the Microchip documentation but they do not explain how to do it. In the end we had to "pretend" the sine values were instruction op-codes and use the TBLRDL and TBLRDH assembly instructions to access them.

The remaining subroutines in the software are straightforward, if somewhat complex. The main loop scans to see whether any buttons are pressed and uses some logic to determine what any given button does, depending on the current screen. It then instructs the LCD to update and, if necessary, changes the waveform generation settings. All the while, the waveform generation code is running as needed to keep the DMA buffers full.

S/PDIF output

The S/PDIF output code is a little tricky. The S/PDIF bi-phase serial stream encodes 64 bits per sample, so for 96kHz the bit rate is 96,000 × 64 = 6.144Mbits/second. Logically, the easiest way to generate this stream is with some kind of serial output peripheral, such as SPI. However, the bi-phase (aka NRZI) encoding complicates matters.

Rather than adding external bi-phase encoding hardware, we decided the best approach was to double the serial bit rate and do the bi-phase encoding in software. This makes the maximum bit rate 12.288MHz. Fortunately, this is within the capabilities of the Data Conversion Interface (DCI) unit in the dsPIC33. However, the maximum clock rate it is able to generate internally is the master clock divided by four, ie, 10MHz.

The solution is to generate the clock externally and use the DCI in slave mode. The 12.288MHz clock signal from the 74HC393 is fed into the DCI and this determines the rate at which data is read out of RAM via DMA and streamed to the DCI data output.

In order to make the software bi-phase encoding fast, a 256-entry, 16-bit look-up table is used. This allows us to take eight bits of data and with a single RAM lookup and conditional bit inversion, compute the bi-phase encoded bit sequence.

Then there's the issue of the logical bitstream generation, ie, coming up with the S/PDIF data stream itself. It involves combining the audio sampling data with some status bits. We generate a table of these bits when the mode is set and feed them into the logical stream as it's generated to save time.

What's coming

That's all for this month. Next month, we'll show you how to build the two boards and install them in the case. SC

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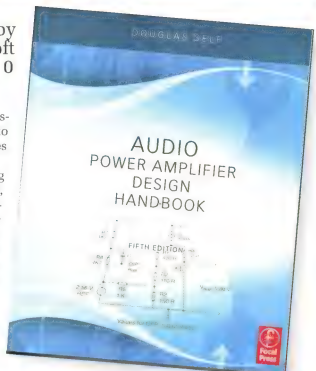
BOOK REVIEW

By Nicholas Vinen

Audio Power Amplifier Design Handbook by Douglas Self. 5th Edition, published 2009. Soft covers, 190 x 235mm, 463 pages. ISBN 978 0 240 52162 6. RRP $130.00.



This is the latest edition of the book that SILICON CHIP reviewed in September 2006. For those not familiar with Douglas Self, he has spent the last few decades diligently analysing audio power amplifier designs in order to fully understand them.

As a result, he has pioneered several techniques which are now virtually standard in hifi amplifier design, resulting in major fidelity improvements.

This edition adds three chapters: "Class-XD: Crossover Displacement Technology", "Power Amplifier Input Systems" and "Input Processing And Auxiliary Subsystems".

In addition, several of the previously existing chapters have been improved, including the addition of three newly discovered sources of amplifier distortion, bringing the total to eleven. The new edition also has 35mm wider pages than the last, which means the diagrams are larger and easier to read, as well as leaving room for additional text.

The first new chapter, on the Class-XD topology, is quite interesting and describes technology that the Author has developed for Cambridge Audio. It also features a comparison of the efficiency/performance trade-offs that are inherent in analog amplifier design. His new output stage is a compromise which offers better efficiency than Class-A, while retaining some of its low distortion characteristics.

As is typical of his work, he doesn't just talk about the benefits but illustrates them with comprehensive graphs showing distortion vs. power measurements for several different output configurations.

The second new chapter, on input systems, has some useful information about audio signal levels, op amps and filtering arrangements. The early portion deals with audio signalling basics – the signal level, balanced and unbalanced transmission etc. It then goes into detail about the challenges of input design.

Despite the title, analog outputs are also covered, both balanced and unbalanced types. The chapter contains several useful schematics for implementing high-performance input and output systems.

The third new chapter, on auxiliary subsystems, is relatively short but touches on a number of important subjects. It includes three very useful schematics – a combined subsonic and ultrasonic filter to remove unwanted frequencies from audio signals, a simple LED bargraph power meter and a circuit for switching an amplifier on when an input signal is present.

There are several other simpler schematics and a discussion of ground lift switches, signal phase reversal, electronic crossovers and infrared remote controls etc.

For those unfamiliar with the earlier edition, the remainder is jam-packed with graphs, schematics, tables and fascinating insights about the internal workings of power amplifiers, as well as techniques to optimise their performance.

A typical Douglas Self approach to any sub-system is to break it into pieces, quantify how much each diverges from ideal behaviour, devise a number of alternate approaches, then measure the performance of each. By using this technique throughout the design, he is able to demonstrate not only the best overall configuration but impart to the reader a profound understanding of how he arrives at that conclusion.

As an example, in the section explaining the Voltage Amplification Stage (VAS) – it joins the input and output stages – the Author presents six different implementations. He then goes on to discuss the relative merits of each and ultimately determines which contributes the least distortion. Other considerations, such as noise, temperature and reliability, are also examined when appropriate to that chapter.

It isn't all about transistors and circuits, though. The first chapter does a good job of explaining why measurements are vital for improving the sound quality of a power amplifier and justifies why the particular techniques he relies on (eg, THD comparisons) are a valid way to determine whether any given change can be said to improve sound quality or not.

This is important since if there is no definitive way to determine which design is better, then it's impossible for any two people to agree on how to go about designing a good amplifier. Also, it's worth noting that this book, like the previous edition, has a chapter on digital (Class D) amplifiers.

. . . continued on page 103

A Low Capacitance Adaptor for DMMs

This neat little adaptor allows a standard digital multimeter to measure low values of capacitance – from less than one picofarad to over 10nF. It will allow you to measure tiny capacitors or stray capacitances in switches, connectors and wiring.

By JIM ROWE

Although some modern digital multimeters do provide capacitance measuring ranges, these are generally not particularly useful when it comes to measuring low value capacitors or the stray capacitance associated with connectors, switches and other components.

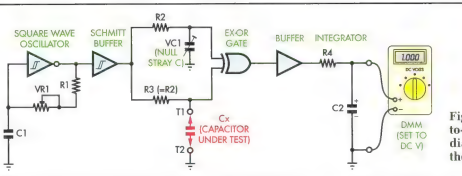
For most of these small capacitance measurements you normally need to use a dedicated low-value capacitance meter and these can be a bit pricey.

The Adaptor is easy to build, with all of the components mounted on a small PC board. The board fits into a box which is small enough to be used as a dedicated 'low capacitance probe' for the DMM, making it well suited for measuring stray capacitances. Just about any modern DMM is suitable for the Capacitance Adaptor, provided it has an input resistance of 10MΩ or 20MΩ.

How it works

Essentially the Adaptor works as a capacitance-to-DC-voltage converter, as shown in Fig.1.

First we generate a square wave 'clock' signal with a frequency of between 110kHz and 1.1kHz (depending on the measuring range) using a simple relaxation oscillator based on capacitor C1, resistor R1, trimpot VR1



EXCLUSIVE-OR GATE TRUTH TABLE		
INPUT A	INPUT B	OUTPUT
L	L	L
L	H	H
H	L	H
H	H	L

Fig.1: it's essentially a capacitance-to-DC-voltage converter, as this block diagram shows. The truth table for the exclusive-OR gate is shown above.

and a Schmitt trigger inverter. This square wave signal is then passed though a Schmitt buffer stage to 'square it up' and produce a waveform with very fast rise and fall times.

The output from the Schmitt buffer is then split two ways and passed through identical resistors R2 and R3. Then they are fed to the two inputs of an exclusive-OR (XOR) gate. The signal which passes through R2 has a small trimmer capacitor VC1 connected from the 'output end' of R2 to ground, while the signal which passes through R3 has the capacitance which is to be measured connected from the output end of R3 to ground (ie, between terminals T1 and T2).

So each signal is fed to the inputs of the XOR gate via an RC delay circuit. The combination of these two RC delay circuits and the XOR gate form a simple 'time delay comparator'.

Remember that when both inputs of a XOR gate are at the same logic level (either high or low), its output is low. And whenever the two inputs are at different logic levels, its output switches high. This is summarised in the truth table associated with Fig.1.

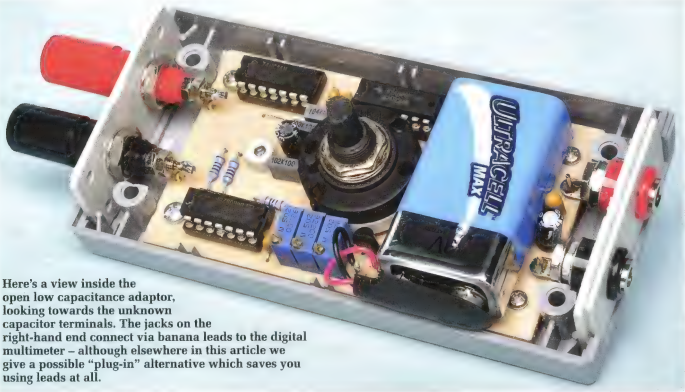
Now consider the situation where there is no discrete capacitor connected between the test terminals, so there will only be a small 'stray' capacitance between them. As a result, there will only be a very short delay in the signal passing through R3 to the lower input of the XOR gate.

If trimmer VC1 is set to provide the same low capacitance for the signal passing through R2, the two signals applied to the inputs of the XOR gate will be delayed by the same amount of time, and so will arrive at the gate inputs 'in sync' – rising and falling at exactly the same times.

In this situation the output of the XOR gate will remain low at all times, because both inputs of the gate are always high or low, both switching together between the two levels. But when we connect an unknown capacitor (Cx) between terminals T1 and T2 the signal passing through R3 will be delayed more than the signal passing through R2.

So now the lower gate input will switch high and low a short time after the upper input and as a result, the logic levels of the two gate inputs will be different for short periods of time following each H-L or L-H transition of the square wave signal.

The output of the XOR gate will switch high during these transition delays, generating a series of positive-going puls-



Here's a view inside the open low capacitance adaptor, looking towards the unknown capacitor terminals. The jacks on the right-hand end connect via banana leads to the digital multimeter – although elsewhere in this article we give a possible "plug-in" alternative which saves you using leads at all.

es with their width directly proportional to the extra delay time caused by the unknown capacitor Cx.

In fact the width of the pulses will be directly proportional to the value of unknown capacitor Cx, because we deliberately limit the delay time to a relatively small proportion of the half-wave period of the square wave 'clock' signal.

The rest of the circuit is used as a simple integrator, to convert the positive-going pulses into a DC voltage. We feed the pulses through a non-inverting buffer, to ensure the pulses are all of constant peak-to-peak amplitude and then through the integrator formed by series resistor R4 and shunt capacitor C2.

The average DC voltage developed across C2 is directly proportional to the width of the pulses and it is this DC voltage that is measured by the DMM.

Although we are only using a simple RC combination to perform this integration, the relationship between the pulse width and the output DC voltage is reasonably linear because we have deliberately limited the integration to the initial 20% of the exponential RC charging and discharging curve.

That's why the nominal full-scale reading on each of our capacitance ranges is only 1.000V, even though all of the Adaptor circuitry operates from a 5V supply rail.

In fact, you can use the Capacitance Adaptor to measure capacitors with a value of more than the nominal full scale value on each range but the readings won't be as accurate as those for lower values because of the increasing curvature of the R4-C2 charging/discharging exponential.

Specifications

Three measuring ranges –

Range A:	0.1pF = 1mV, *[gives a range from below 0.3pF to above 100pF.]*
Range B:	1pF = 1mV, *[gives a range from below 1pF to above 1000pF (1nF)]*
Range C:	10pF = 1mV, *[gives a range from below 10pF to above 10.0nF.]*
Accuracy:	Within approximately 2% of nominal full scale reading, *(assuming you can calibrate ranges using capacitors of known value).*
Power:	9V alkaline or lithium battery.
Current drain:	less than 5mA.

Circuit details

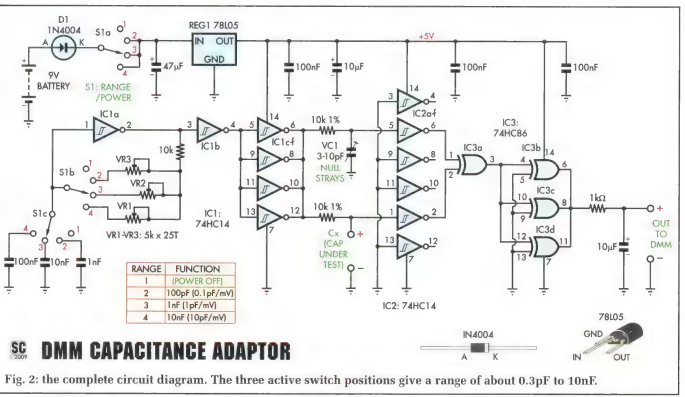
The full circuit of the Capacitance Adaptor is shown in Fig.2. Schmitt inverter IC1a operates as the square wave clock oscillator. The only difference from Fig.1 is that switches S1b and S1c allow three different C1/VR1 combinations to be used, for oscillation at three different frequencies, to provide the three measurement ranges.

The remaining inverters in IC1 (a 74HC14 device) are used to form the non-inverting Schmitt buffer following the oscillator. IC1b squares up the signal initially and then drives IC1c-f in parallel to re-invert the signal and square it up even further.

The paralleled outputs of the clock buffer drive the upper and lower arms of the 'time delay comparator'. Here the two 10kΩ 1% resistors correspond to R2 and R3 in Fig.1. However, the signals from the two delay circuits R2/VC1 and R3/Cx now pass through another pair of Schmitt inverters, IC2c & IC2a, which are part of a second 74HC14.

This has been done to 'square up' both signals, to ensure that the width of the output pulses from IC3a maintain their linear relationship to the value of the capacitor being measured.

Although this squaring up is only necessary for the lower (Cx) signal, because of its longer delay and hence greater 'rounding', we also pass the upper (VC1) signal through an identical inverter to ensure that it is inverted in the same



RANGE	FUNCTION
1	(POWER OFF)
2	100pF (0.1pF/mV)
3	1nF (1pF/mV)
4	10nF (10pF/mV)

Fig. 2: the complete circuit diagram. The three active switch positions give a range of about 0.3pF to 10nF.

way as the lower signal. Thus both signals have the same nominal phase and both signals have the same propagation delay, ie, via IC2a & IC2c.

IC3a is the XOR gate of the time delay comparator, while the remaining three gates in IC3, a 74HC86 device, are used as a non-inverting buffer to drive the RC integrator.

Here the 1kΩ resistor corresponds to R4 in Fig.1, while the 10µF tantalum capacitor across the output jacks corresponds to C2. Gates IC3b-d are used simply as non-inverting buffers by tying the second input of each to ground logic low.

Power supply

Power is supplied by a 9V alkaline or lithium battery, with diode D1 used to prevent any possibility of reverse-polarity damage. Switch S1 acts as a combined power and range switch, with S1a is used to switch off the Adaptor in the fourth (fully anticlockwise) position.

The Adaptor circuit needs to run from a regulated DC supply rail, so that the measurements don't vary as the battery voltage droops with age. Regulator REG1 is therefore used to provide a regulated +5V supply rail, provided the battery voltage remains above 7.5V.

Since the current drain of the circuit is below 5mA, we are able to use a 78L05 regulator (TO-92 package) for REG1. The 47µF, 10µF and 100nF capacitors are used to filter any noise and switching transients which may appear on the +5V supply line.

Construction

As you can see from the photos and the PC board overlay diagram of Fig.3, virtually all of the components used in the Adaptor are mounted on a small PC board, measuring 90 x 50.5mm and coded 04103101. This fits snugly inside a plastic instrument box measuring 120 x 60 x 30mm.

The only components which are not mounted directly on the PC board are the binding posts and the output 'banana' jack sockets (or banana jacks themselves) for connection to the DMM. The former mount on one end of the box while the latter mount on the other end.

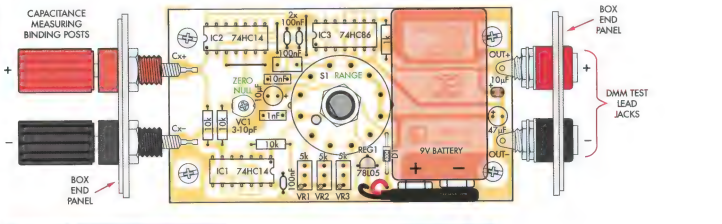
In each case the posts and jacks connect to PC board pins. Note that the binding posts and jacks are both spaced apart by the standard 19mm (3/4"), to make them compatible with double-plug connectors etc.

Before you begin fitting the components to the PC board, it's a good idea to open up the box and check that the board will slip inside the lower half (the half with the countersunk holes for the final assembly screws). You may need to file off a small amount from all four sides of the board so that it will slip down to rest on the support pillars moulded in the inside of the box.

You may also need to file small shallow rounded recesses in the two ends to clear the larger pillars around the box assembly screw holes. It's much easier to do this before any components have been mounted on the board.

Begin board assembly by fitting the three wire links, followed by the six PC pins: two each for the input terminals and output jack connections and two for the battery clip lead connections (just below the positions for D1 and REG1, at lower centre).

Next, fit the three 14-pin IC sockets for the three ICs, noting that the socket for IC1 should have its notched end to the right while those for IC2 and IC3 are to the left, as on the overlay diagram of Fig.3. Then fit the four fixed resistors, followed by the three 5kΩ 25-turn trimpots. Make



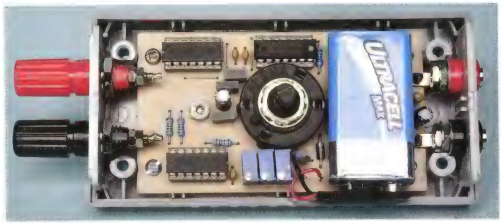


Fig.3 (above): life-size component overlay diagram, with posts and jacks, plus a slightly enlarged photograph of the same thing. The only thing not shown here is a small cable tie which should be used to secure the battery snap leads to the PC pins – flexing of the leads when the battery is changed is a sure-fire recipe for them to break off at the solder joints.

Connecting to your DMM: another approach

While this project was being prepared for publication, it occurred to us that there was another, perhaps even more logical way to connect the adaptor to a DMM – particularly if you would like a more "hands free" operation.

This takes into account the fact that the overwhelming majority of DMMs which use 4mm sockets (and we would have to say ALL pro-quality units) have a standard 19mm spacing between those sockets.

Therefore, we reasoned that it would be quite sensible to replace the banana jack sockets on the "output" end with banana jacks – thus allowing the unit to be plugged directly into the DMM.

At the expense of some flexibility, this would mean that there would be no need to make up a set of Adaptor-to-DMM leads. Try as we might, we could not easily find a set of these already made up. You can get banana to probe, banana to alligator clip, banana to multiple adaptors, even banana to blade fuse fittings (for automotive use) but banana to banana? Nada. Zilch. Nyet!

So the only alternative would have been to buy some figure-8 red and black lead (believe it or not, also getting hard to find in lightweight, flexible type!), two pairs of red and black banana plugs and solder them onto the lead.

The alternative approach, as shown above and below, is to fit a pair of red and black banana plugs through the end of the case. We used a scrap of PC board, cut and shaped the same as the end panels, with a strip of copper removed down the middle. Drilled appropriately, this gave us a handy "platform" to which we soldered the two banana plugs (inside) without their plastic shrouds. The plugs were then soldered back to their respective PC pins using short lengths of tinned copper wire (eg, resistor/capacitor lead offcuts).

Presto – a plug-in adaptor. And if you want to use it off the DMM? Simply use a banana-to-alligator clip lead set.

sure you place the latter with their screwdriver-adjustment screw heads at lower left.

Now add the fixed capacitors, taking care to place the polarised 47µF and 10µF caps with the correct orientation, as shown in the overlay diagram. Then fit the mini trimcap (VC1) in position, with its 'flat' end to the left as shown.

Rotary switch S1 is fitted next, after cutting its spindle to about 10mm long and filing off any cutting burrs with a small file. The switch mounts on the board with its moulded locating spigot at approximately the '7:30' position, viewed from above and with the board orientated as shown in the overlay diagram (ie, with IC1 at lower left).

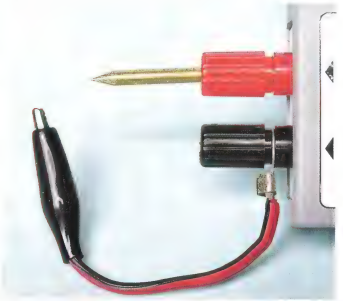
S1 is a "universal" type of switch offering a number of switch positions so after it is installed, it needs to be set for the four positions we require.

Remove the nut and lockwasher from its threaded bush and then lift up the stopwasher as well. Then turn the spindle anticlockwise by hand as far as it will go and refit the stopwasher with its 'stop pin' passing down through the hole between the digits '4' and '5' moulded into the switch body. Then replace the lockwasher and the nut, threading the latter down until it's holding down both washers firmly.

You should now find that if you try turning the spindle by hand, it will have a total of four positions – no more and no less.

Don't be caught out by the old trap of thinking you only have three positions because it only clicks three times. Remember it clicks to three *more* positions from its end position.

Then you can fit REG1 and D1 to the board, noting their correct polarity. Plug IC1-3 into their respective sockets and your board assembly will be complete. You put it aside while you drill the various holes which need to be cut in



Another way of measuring "C" – using a small length of 4mm brazing rod with a point and slot, (shown below) you can fashion a "probe" to get into tight spots.

the top, bottom and end panels of the box.

Preparing the box

Two holes need to be drilled in each of the end panels and five holes in the top of the box. You will also need to cut away a small amount from the sides of the assembly screw surround pillars on both the top and bottom of the box, to provide clearance for the 'rear ends' of the capacitance measuring binding posts and DMM test lead jacks, when the box is assembled. This cutting away can be done with a small milling cutter in a high speed rotary tool or done manually with a sharp hobby knife (careful!).

Both pairs of holes in the end panels need to have a diameter to suit the binding posts and banana jacks you are using. They are located on the centre line of their panel but 9.5mm away from the centre-line in each case - so the binding posts and jacks both end up spaced apart by the standard figure of 19mm (3/4").

The five holes in the top of the box can be located quite accurately using a photocopy of the front panel artwork (or a printout from siliconchip.com.au) as a template, because you'll see that this includes a dashed outer rectangle to show the outline of the box itself. The central hole for the power/range switch is 10mm in diameter, while the other four holes are 3.5mm in diameter, which allow adjustment of the zero null trimcap and calibration trimpots when fully assembled.

The exact location and amount of material which must be removed to clear the binding posts and banana jacks will depend very much on the actual posts and jacks that you use. You can see from the internal photos where material needed to be cut away for the posts and jacks used in the prototype.

(By the way, the binding posts used were the PT-0453 & PT-0454 from Jaycar, while the banana jacks were the PS-0406 & PS-0408 – also from Jaycar. Other posts and jacks may need the removal of either less or more material but you should be able to fit in most types that are currently available.)

The last step in preparing the box is to make another photocopy or printout of the front panel artwork on either an adhesive-backed label sheet with a piece of clear self-adhesive film over the top or, for really long life and best protection, plain paper laminated in a plastic sleeve. The label is then cut out and applied to the front of the upper half of the box, lining up the holes of course.

First assembly steps

The first step in assembling the Adaptor is to mount the binding posts and banana jacks on their respective end panels, tightening their mounting nuts to make sure they won't be able to rotate and work loose. Note that in the case of the banana jacks, you also need to mount them with their solder tags orientated vertically downwards so that after the nuts are tightened, the tags can be bent up by 90°. This is to allow the holes in the tags to be shortly slipped down over the terminal pins in the PC board.

Next lower the PC board assembly into the lower half of the box, and fix it in place using four very small self-tapping screws (no longer than about 5mm). Then you should be able to lower the end panel with the output jacks down into the slot at that end of the case, with the tags on the rear of the jacks passing down over the terminal pins of the board. When the panel is down as far as it will go, you can solder the jack tags to the terminal pins to make the connections permanent.

The other end panel (with the binding posts) is then fitted in much the same way, except that in this case there are no solder tags at the rear of the posts. Instead you may need to bend over the terminal pins on the PC board so that they clear the rear spigots of the binding posts and are alongside them, ready for soldering. Then when this panel is down as far as it will go, the binding posts can be soldered to the board pins.

The next step is to cut the battery snap lead wires fairly short -- about 20mm from the snap sleeve - then strip off about 5mm of insulation from the end of each wire, tin them and solder them to the PC board pins just below REG1 and D1. The positive (red) wire goes to the pin immediately below D1, as you can see from the overlay diagram and pics. Ideally, these wires should be secured to the PC board pins with a very small cable tie.

After checking that everything looks correct, connect the battery to the battery snap and your Low Capacitance

Parts List – DMM Low Capacitance Adaptor

1 PC board, code 04103101, 90 x 50.5mm
1 Utility box, 120 x 60 x 30mm (eg Jaycar HB6032, Altronics H0216)
1 3 pole 4 position rotary switch (S1) (eg Altronics S-3024, Jaycar SR-1214)
1 Instrument knob, 16mm diameter
1 Binding post, red
1 Binding post, black
1 Banana jack socket, red
1 Banana jack socket, black
1 9V alkaline or lithium battery
1 9V battery snap lead
3 14-pin DIL IC sockets
6 1mm diameter PC board terminal pins
1 small cable tie
4 Small self tapping screws, max 5mm long

Semiconductors
2 74HC14 hex Schmitt inverter (IC1,IC2)
1 74HC86 quad XOR gate (IC3)
1 78L05 low power +5V regulator (REG1)
1 1N4004 1A diode (D1)

Capacitors
1 47µF 16V PC electrolytic
1 10µF 16V PC electrolytic
1 10µF 25V TAG tantalum
3 100nF multilayer monolithic ceramic
1 100nF MKT metallised polyester
1 10nF MKT metallised polyester
1 1nF MKT metallised polyester
1 3-10pF mini trimcap (VC1)
3 known value reference capacitors (see text)

Resistors (0.25W 1% unless specified)
3 10kΩ 1 1kΩ
3 5kΩ 25T cermet trimpots (VR1,VR2,VR3)

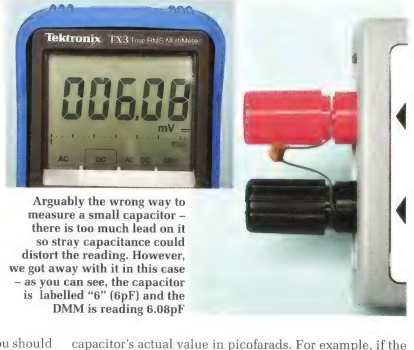
Adaptor should be just about ready for its initial set-up. All that remains is to fit the operating knob to the spindle of switch S1 temporarily, to make things easier during the set-up operation.

Initial set-up & calibration

Select the DMM that you are going to use with the Adaptor and make up a connecting lead to connect the output of the Adaptor to its DC voltage inputs. In most cases the lead will need standard banana plugs at each end.

Then connect the Adaptor and DMM together using this lead and turn on the DMM, switching it to a fairly low DC voltage range, eg the range with a full-scale reading of 1.999V or 1999mV.

Turn S1 to the first position ('Range A') for the present. You should find that the DMM will give a relatively low reading - less than 10-15mV. This reading is due to the fact that the 'stray' capacitance of the Adaptor's input binding posts is not as yet being nulled by trimpot VC1. So the next step is to use a small plastic or ceramic alignment tool to adjust VC1 very carefully to get a minimum or 'null' in the DMM's reading. You should be able to bring the reading down to below 1mV.



Arguably the wrong way to measure a small capacitor – there is too much lead on it so stray capacitance could distort the reading. However, we got away with it in this case – as you can see, the capacitor is labelled "6" (6pF) and the DMM is reading 6.08pF

If you are able to achieve this null, your Adaptor is very likely to be working correctly and the next step is to calibrate each of the three ranges.

For the three calibration steps you're going to need three polystyrene, polyester or silvered mica capacitors whose values are accurately known, because the accuracy of your Adaptor will depend upon them. The three capacitors should have values close to 100pF, 1nF and 10nF respectively, because these are the nominal full-scale readings of the Adaptor's three ranges.

They needn't have these exact values but ideally you should know their actual values, measured using a calibrated digital capacitance meter or LCR meter.

Once you have these three known-value or 'reference' capacitors the calibration of your Adaptor is relatively straightforward.

With the Adaptor still switched on and set to Range A, first connect the 100pF capacitor to the Adaptor's binding posts using the shortest possible lead lengths. Then adjust trimpot VR3 until the DMM reading in tens of millivolts corresponds to the capacitor's actual value in tenths of a picofarad (pF). For example, if your capacitor has a known value of 101.5pF, adjust VR3 until the DMM reading becomes 1015mV or 1.015V.

Once this is done you repeat this process on Range B, this time using the 1nF reference capacitor and trimpot VR2 to make the adjustment. VR2 should be adjusted until the DMM reading in millivolts corresponds to the capacitor's actual value in picofarads. For example, if the capacitor has a known value of 1.013nF or 1013pF, adjust VR2 until the DMM reading is 1.013V.

Finally repeat the process again for Range C, this time using the 10nF reference capacitor and trimpot VR1 to make the adjustment. The correct setting for this range is where the DMM reading in millivolts corresponds to the capacitor's actual value in tens of picofarads. For example if the capacitor has a value of 9.998nF, the DMM reading should be 999.8mV or 0.9998V.

That's all there is to it. Once you have calibrated each range in this way, you can turn off the Adaptor using S1, remove the knob from its spindle and then fit the top of the box carefully - making sure you don't catch the battery snap wires under the side. Then turn the complete box over and fit the four countersunk head screws used to fasten the top to the bottom. After this all that should remain is to refit the knob to the spindle of S1.

Just before you declare your Adaptor ready for use, though, it's a good idea to check the setting of null trimcap VC1, because the stray capacitance associated with the input binding posts does tend to change very slightly when the box is fully assembled.

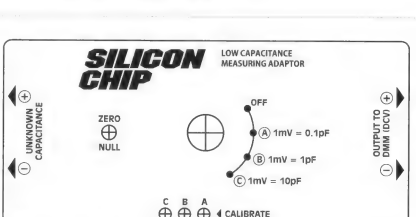


Fig.4 same-size front panel artwork which can also be used as a template for drilling the five holes required. This can also be downloaded from siliconchip.com.au

siliconchip.com.au

So switch the Adaptor on again, in Range A but with nothing connected to the binding posts and if necessary adjust VC1 using the alignment tool (passing down through the ZERO NULL hole in the front panel) to see if you can improve the null reading on the DMM.

Using the Adaptor

Putting the Adaptor to use is also quite straightforward. Basically it's just a matter of hooking it up to your DMM, setting the DMM to the 0-2V DC range and then turning on the Adaptor to the appropriate range and connecting the capacitor to be measured to its binding posts. Then you read the voltage on the DMM and convert this to find the capacitance, using the legends printed on the Adaptor's front panel.

But there are a few things to bear in mind if you want to achieve the best measurement accuracy. For example when you are measuring really low value capacitors in particular (ie, below 100pF), try to connect them to the binding posts with the shortest possible lead length. This is because any excess lead length will add extra stray capacitance, as well as a tiny amount of lead inductance. Both of these will degrade reading accuracy, because measurements on Range A are done at a frequency of about 110kHz.

If you can't connect a capacitor directly to the binding posts with minimum lead lengths, an alternative is to make up a pair of short but stiff (ie, heavy gauge) test leads, each with a banana plug at one end and a small crocodile clip at the other. The leads should then be plugged into the binding posts, and zero null trimcap VC1 then adjusted with an alignment tool (on Range A) to null out the additional stray capacitance.

Then you can connect the capacitor to the test lead clips and measure its capacitance as before.

You can follow a similar procedure to use the Adaptor as a handheld 'probe' to measure stray capacitance, as opposed to measuring the value of discrete capacitors. Here it's a good idea to make up a small 'probe tip' out of a 30mm length of 4mm (5/32") diameter brass rod (eg, brazing rod), with a fairly sharp point ground or filed at one end and the other end slit down the centre with a fine hacksaw for about 8-10mm. The slit end can then be expanded slightly with a small screwdriver, so that it will just slip inside the socket on the front of the Adaptor's positive (red) binding post and stay in position. You also need to make up a short but stiff test lead for the 'earth return', with a spade lug at one end (to be clamped under the negative binding post) and a small crocodile clip on the other end to connect to the reference metalwork for the stray capacitance to be measured. The probe tip and earth return lead I made up are visible in one of the photos.

Here again you need to null out the additional stray capacitance associated with the added probe tip and earth return lead, before making the actual measurement. But this is again easy to do: simply fit the probe tip and earth return lead, turn on the Adaptor to Range A and adjust VC1 with an alignment tool for the deepest null in the DMM reading. Then you can proceed to make your measurements of stray capacitance.

Get the idea? It's quite in order to use test leads and/or measuring jig attachments to connect whatever capacitance you want to measure to the Adaptor's binding posts, providing you null out the added stray capacitance using VC1 (on Range A) before making the actual measurements. SC

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Very, Very Accurate

THERMOMETER

Based on the very accurate Dallas DS18B20 digital temperature sensor, this thermometer/thermostat provides accurate readings to one decimal point. The LCD shows current, minimum and maximum temperature readings. An internal buzzer will sound when temperature limits are exceeded. It is intended for controlling air conditioners, heaters, cool rooms, wine cellars, etc. The software is user-customisable.

Design by Michael Dedman (Altronics)
Words by Michael Dedman and Nicholas Vinen

THERMOSTAT

This digital thermometer/thermostat is designed to be easy to use, accurate and stable for a variety of applications. With an overall range of -55°C to +125°C, it can read and display temperature with a great deal of precision – 0.5° over most of its range – as well as trigger a warning buzzer or external devices if the temperature goes outside a specified range.

The full circuit is shown in Fig.1. The heart of the device is the Atmel ATTiny861 microcontroller which has 8KB of program flash, can run up to 20MHz and is specified for use in commercial and industrial applications.

The very accurate Dallas/Maxim DS18B20 is the temperature sensor. It has its own inbuilt Analog-to-Digital Converter (ADC) and one-wire digital communication module, allowing it to transmit the real temperature in digital format directly to the microcontroller. This results in more stable and accurate readings than many purely analog temperature sensors, as well as removing the need for any kind of biasing circuitry to allow sensing of temperatures below 0°C.

As a result, the specifications are outstanding. They include accuracy of ±0.5°C from -10°C to +85°C and a full range of -55°C to +125°C. The minimum and maximum temperature thresholds can be specified in 0.1°C increments. You can decide whether the piezoelectric buzzer should sound if the temperature reading goes above the maximum threshold, below the minimum or both.

On-board are two miniature relays with normally open (NO) and normally closed (NC) contacts available for triggering external devices under either or both conditions. The software also allows you to adjust to the hysteresis, which eliminates "relay chatter" from occurring during switching.

We have reports that it is possible to mount the sensor up to 300m away from the control box without affecting the performance, although the furthest Altronics has tested it is 100m. If you are planning on a cable run more than a few tens of metres you may find it necessary to replace the 4.7kΩ pull-up resistor on the sensor signal line with a lower value, due to the increased capacitance of a longer cable.

There is also an in-circuit programming header on the PC board. The ATTiny861 comes -pre-programmed so there is no requirement for you to use it. However, more advanced constructors may wish to modify the microcontroller program to suit their requirements.

You can do this by using the BASCOM compiler for Atmel microprocessors (available from **www.mcselectronics.com**). An Atmel programmer will also be required, to write the new code to the ATTiny861's flash memory. Depending upon the pin configuration of your programmer you may also need to make an adapter to suit the programming header on the PC board.

The tiny (TO-92 size) Dallas/Maxim DS18B20 temperature sensor (shown here about twice life size with heatshrink insulation) gives this thermometer its accuracy and wide measurement range.

Features

- **Measures temperatures from -55°C to +125°C**
- **0.5°C accuracy from -10°C to +85°C**
- **Sensor can be up to 300m away from controller**
- **Two relays with N/O or N/C contacts for switching devices**
- **Buzzer alert for over and under-temperature**
- **Adjustable hysteresis to prevent output oscillation**
- **Runs from 8-35V DC @ 120mA**

Flexibility

Unlike many commercial products, this project provides separate relays for the upper and lower temperature thresholds, and provides normally open and normally closed contacts to give maximum flexibility. You can even hook up a heater to one relay and a cooler to the other, if necessary.

Keep in mind the limited voltage and current ratings of the- relays (0.5A @ 125VAC or 1A @ 24VDC). So if you want to switch a mains device or provide more current, the simplest way is to use the thermostat's internal relays to drive 250V AC-rated external relays. You can use the same voltage supply for the thermostat to drive the external relay(s), say 12V or 24V DC.

Applications

Mike Dedman was so enthused with the features of this device he built two. One is interfaced to his home aquarium heater and this holds the water temperature at 25±1°C. Rex Hunt may kiss fish but the fish kiss him for

keeping their home at such a stable temperature!

The second is interfaced to his car air conditioning system. Most cars have no real temperature control in air conditioning mode and as a result the compressor cycles on and off continuously until the windscreen freezes up. Thanks to its adjustable temperature limits, this project can, for example, keep a car's interior at a comfortable 21±0.5°C.

It achieves this by switching on the compressor until the interior temperature gets down to 21°C, then air conditioning turns off and remains off until it goes above 21.5°C (ie, a temperature rise of 0.5°C). Not only is this a great deal more comfortable for passengers but it also improves the fuel economy of the car.

These are just two of the practical uses that this unit can be used for. Other uses – we're sure you'll think of many more – include wine cellars, cool rooms, home-brew setups, fan heaters and fan coolers.

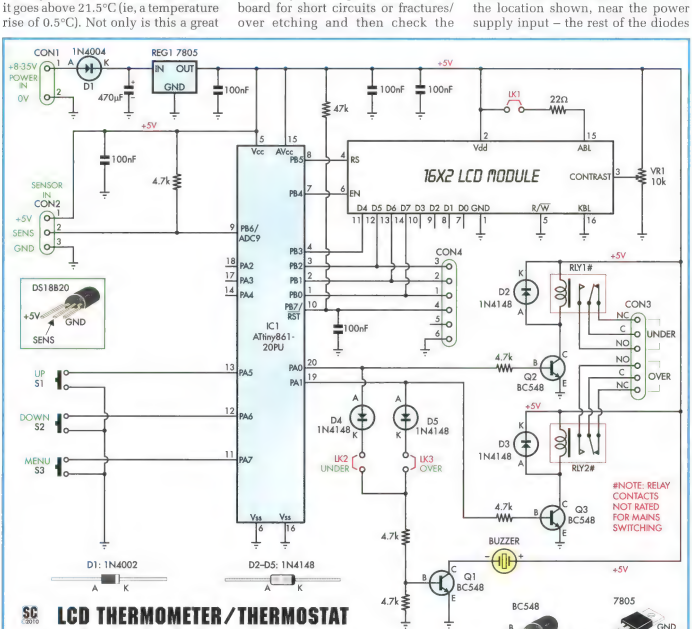
Construction

The component overlay of the PC board assembly is shown in Fig.2, with the LCD module piggy-backed on the main board.

Start by checking the tracks on the board for short circuits or fractures/over etching and then check the components against the parts list for completeness. Note that the microcontroller and sensor come packed in anti-static foam – it is best to keep them that way until it is time to install them.

Once you are sure the board has no faults, install the resistors and diodes. Measure each resistor's value with a multimeter before installing it – the colour bands can be hard to read.

Be careful with the diode polarity – check that they are oriented as shown on Fig.2, the component overlay, which will also match the PC board silk screen overlay and be sure to install the 1N4002/1N4004 in the location shown, near the power supply input – the rest of the diodes



LCD THERMOMETER/THERMOSTAT

Fig.1: the thermometer gets its accuracy from the DS18B20 sensor. Its digital output is read and processed by the Atmel microprocessor, which displays the data on the LCD module and also controls the alarm/control circuitry.

are the smaller 1N4148s.

Next, solder in the 14-pin DIL socket for the microcontroller, which goes in the middle of the PC board. Make sure the notch at the end of the socket lines up with the one drawn on the overlay and ensure it is sitting flat on the board before soldering all the pins. Don't install the IC itself yet.

After that, install the buzzer and potentiometer VR1. The buzzer is polarised; it can fit in either way but only one is correct. Make sure the + shown on the sticker or plastic case is facing the + shown on the PC board overlay before soldering it.

Once it's in place you can pull the sticker off. The trimpot is easier; it will only go one way.

Follow with the male pin headers. There is one 6-pin header and three 2-pin headers. Snap off an appropriate length from the strip provided using pliers and solder them into place.

This is also a good time to install the 16-pin female header but first you have to cut it to size. The supplied header has a few too many pins. The easiest way to cut it is with a pair of side cutters – find the 17th pin socket and carefully make a cut in the middle of that pin (ie, not between the 16th and 17th pins, otherwise pin 16 may fall out). Double check before making the cut that there are going to be 16 intact pins left afterwards.

Now it's just a matter of tidying up the remaining bits of plastic left over where you made the cut and you can solder it into place on the PC board. It must be mounted flat on the PC board and parallel with the LCD outline on the silk screen before soldering all the pins – otherwise you will have trouble fitting the LCD later.

Now you can install the three TO-92 package transistors – all are BC548s. Don't mix the temperature sensor up with the transistors (they are all TO-92 packages). If you accidentally solder the sensor onto the board instead, not only is it going to be difficult to remove but it could be damaged.

The pins of the BC548s are too close to fit through the holes on the PC board, so use needle-nose pliers to splay the two outer pins forward and outward (with the labelled side of the transistor being the front) and the middle pin backward. Then bend them all back parallel so that they fit through the holes and solder them in place. The flat face of each is oriented as shown on the overlay.

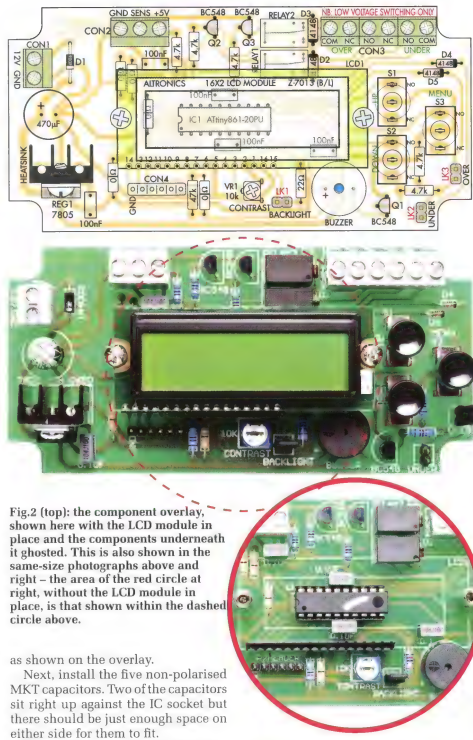


Fig.2 (top): the component overlay, shown here with the LCD module in place and the components underneath it ghosted. This is also shown in the same-size photographs above and right – the area of the red circle at right, without the LCD module in place, is that shown within the dashed circle above.

Next, install the five non-polarised MKT capacitors. Two of the capacitors sit right up against the IC socket but there should be just enough space on either side for them to fit.

Having done that, solder the two relays to the board. They can only go one way around – don't bend the pins and ensure they are sitting flat before soldering them down.

Now fit the sole electrolytic capacitor (470µF) into place. Ensure the longer leg goes into the hole adjacent the + symbol on the silk screen overlay. After soldering it, install the three terminal blocks – 2-way, 3-way and 6-way – into the appropriate locations, ensuring that the wire entry points face to the outside of the PC board.

The 7805 regulator should be loosely fitted to its heatsink before soldering it to the PC board. Insert an M3 x 6mm bolt through the tab of the 7805 regulator. Place a TO-220 silicon washer behind the TO-220 tab, with the bolt passing through the hole. Now screw the regulator and washer onto the heat sink. Don't tighten it completely though – just screw it in most of the way.

Having done that you can now put

Part List – LCD Thermometer/Thermostat

1 PC board, 60 x 122mm, code K.6115A
1 UB3 jiffy box with screened and punched front panel
1 TO-220 heatsink, 10 x 22mm (Altronics H0640)
5 M3 x 6mm pan-head screws
1 12-way screw terminal block, PC-mount (5.08mm pitch)
1 40-way male pin header strip (2.54mm pitch)
1 20-way female pin header strip (2.54mm pitch)
3 Tactile pushbutton switches (Altronics S1393)
2 Mini 1A SPDT relay, 5V coil (Altronics S4111)
1 Self-oscillating piezoelectric buzzer, 3-16V, PC-mount
1 20-pin DIL IC socket
1 Silicone rubber TO-220 washer (Altronics H7210)
2 M3 x 15mm tapped steel spacers
2 Header pin shorting blocks
30cm length of 10-wire ribbon cable
10cm length of 3mm heatshrink tubing

Semiconductors

1 ATTiny861-20PU (pre-programmed by Altronics) (IC1)
1 DS18B20 digital temperature sensor
1 16x2 alphanumeric LCD with backlight (Altronics Z7013)
1 7805 5V positive voltage regulator (REG1)
3 BC548 NPN small signal transistors (Q1-Q3)
1 1N4004 diode (D1)
4 1N4148 diodes (D2-D5)

Capacitors

1 470µF 16V electrolytic
5 100nF 50V MKT polyester (code 100n, 0.1 or 104)

Resistors (0.25W 1%)

1 47kΩ 5 4.7kΩ 1 22Ω 5 0Ω
1 10kΩ horizontal trimpot

the regulator legs into the holes on the PC board and, lining up the two posts on the heat sink with the holes in the PC board at the same time, push the regulator/heat sink assembly until it's right up against the PC board.

Now turn the PC board over and solder the heat sink down. You will need a hot iron as the heat sink will draw a lot of the heat away. Make sure after you've soldered the first post that the heat sink is fully in contact with the PC board surface before attaching the second.

Check that the silicone washer is sitting properly behind the regulator – adjust it if it isn't – and holding it in place, tighten the bolt down. Now the TO-220 package should be held rigidly in place and you can solder its pins to the board and trim the excess.

At this point it's also worth bolting the two tapped spacers to the PC board. They go on the same side as the rest of the components. Make sure the M3 bolts are tightened right up.

Installing the switches

Installation of the push-button switches is a little tricky because they need to sit about 2mm off the PC board in order to project properly through the pre-drilled holes in the lid.

Since they do not sit up against the PC board, you will have to adjust their angle so that they are properly centered with respect to those holes.

First, take one of the switches and check its correct orientation on the PC board. The silk screen shows the "NO" and "NC" ends of each button, and this is also stamped into the metal shield on the side of the switches.

So you will need to check the stamped information to make sure you are orienting them correctly. Once that is done, insert one of the switches through the holes, but not all the way. With its body about 2mm above the PC board, solder the center pin, trying to keep it as close to vertical with respect to the PC board as possible.

Putting it in the box

Assembly is basically complete, so you can now install the PC board in the box – first to check whether it is at the right height and properly centered.

The PC board is held in the box by a "shelf" or notches cut into the ridges molded into the inside surface (there are no mounting screws as such).

Hold the PC board with the component side up and the terminal blocks away from you and tilt the far side upwards. Now lower it into the box until the edge closest to you engages the notches. Then rotate it by pushing the back down until it snaps into place.

It's possible (though unlikely) that, due to manufacturing tolerances, it won't quite fit properly. If this is the case then use a file to slightly reduce one or both sides of the PC board until it fits in place.

If the sides of the box bow outwards with the PC board in place, take it out and file off a small amount from the edges. The easiest way to find out is to rest the lid on top of the box with the PC board inside and check that the edges line up properly. If they do then there is no problem.

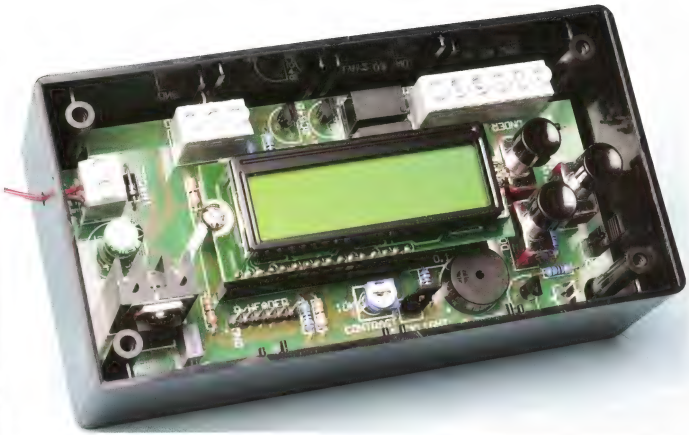
Otherwise file away the PC board until it fits better.

Now place the lid down on top of the box but don't attach the screws. This should allow you to determine whether you have to adjust the button, and if so in which direction, for it to project properly through the appropriate hole in the lid.

The surface of the push-buttons

Resistor Colour Codes

	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	47kΩ	yellow violet orange brown	yellow violet black red brown
❑	5	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	1	22Ω	red red black brown	red red black gold brown
❑	5	0Ω	(single black stripe)	



Here's how it all goes together in the Jiffy Bix, ready for the lid to go on. Watch the power polarity– if it's wrong, it won't work – and the connections to the temperature sensor. If they're wrong, you will probably destroy it!

should stick up slightly through the lid so that you can press them easily, without projecting more than a millimeter or two above it.

Once you have determined how much you need to adjust the push-button, remove the lid and lever the PC board out of the box by grabbing the six-way terminal block and pulling it up and away from the box edge.

With the board out, re-melt the solder joint holding the switch in place and carefully nudge it in the appropriate direction. Then re-install the PC board and repeat this procedure until you are happy with the placement. Then solder the two remaining pins.

Once that is finished you will need to go through the same steps for the other two switches.

Installing the microcontroller

The microcontroller sits under the LCD so must be installed it first. But before you can do that it's a good idea to check what you have built so far is working correctly.

To do so, wire an ammeter (or a multimeter on, say, its 500mA range) in series with a suitable power supply (12V is a good choice) and connect it to the power input terminal block with a couple of lengths of wire.

Switch on the power supply and note the current drawn. It should be less than 20mA. Now check the voltage across pins 5 and 6 of the microcontroller DIL socket. It should be close to 5V – if it does not, disconnect power and check for incorrectly installed components.

If (and only if) all is OK, (with power still disconnected) insert the microcontroller IC in its socket. Bend its pins so that they fit in the socket and push it down firmly. Make sure you don't put it in backwards – the notch at the end of the IC package must line up with the one on the socket.

Soldering the LCD

Like the buttons, the LCD is a little tricky to solder due to physical mounting requirements. The easiest way to do it is to snap off a length of 16 pins from the remaining male pin header strip and keeping the longer part of the pins facing down, loosely push it down into the female header you've already soldered to the PC board.

Now place the LCD down on top of the spacers so that the header pins fit through the row holes on the LCD module and bolt it down to the tapped spacers using the remaining M3 x 6mm bolts. By the way, don't remove the plastic protecting the LCD screen yet.

Once the LCD is bolted down and can't move, use a small flat-bladed screw driver to push the male header up or down so that the tips of the pins stick up a tiny bit through the LCD module. They should only be about half a millimetre above the LCD module board surface. That way the other end of the pins will be properly engaged to the female header.

Ensure that it is sitting parallel with the LCD, so that the same amount of pin sticks up at both ends. Now carefully, without moving the header, solder it to the LCD module from the top.

Testing and set-up

To properly test the thermometer it is necessary to wire up the temperature sensor. Your final installation may require a different arrangement but for now the easiest thing to do is to use the length of ribbon cable supplied with the kit.

Strip off three wires from the ribbon cable and pull the wires apart until

there are single strands 4cm long at one end and 8cm at the other. Strip and tin about 5mm of conductor from all three wires at both ends.

Cut three equal lengths of the thin heatshrink tubing included in the kit – slightly longer than the legs on the temperature sensor. One at a time, slip a length of heatshrink onto one of the 8cm long wires and push it down as far as you can. The tinned end of the wire should be sufficiently clear of the heatshrink tubing so that when you solder it, it won't shrink yet. Repeat for all three pins.

Slide the heatshrink up over the pins and solder joints and shrink it. This should leave no exposed metal that could short together.

You may want to shrink a short length of 6mm diameter heatshrink tube over the sensor, pins and ends of the wire, as we have shown in our photos. This way the whole sensor is electrically insulated and the pins can't be bent or move easily.

Now you can screw the other end of the ribbon cable into the three-way terminal block on the PC board, making sure that the three wires connect to their correct terminals, as shown on the circuit diagram. If you get them mixed up it could damage the sensor.

It's alive!

Re-apply power and check that the thermometer is functioning properly. Check that current draw is below 100mA. If it seems OK, adjust the contrast potentiometer (VR1) with a small Philips screwdriver until text is visible on the display.

The top line should show the current temperature reading, while the bottom line alternates between the minimum and maximum values that have been seen during the current session. Pick up the temperature sensor between two fingers and check that the temperature rises as your body heats it. When you let go it should slowly fall back to the ambient temperature.

Preparing the case

Before you can finish the set-up and installation it's necessary to drill some holes in the sides or rear of the case for the power supply wiring, temperature sensor cable and, if necessary, cables for connection to the relay(s).

As you can see in the photos, we have drilled one small hole for the power wires and one for the sensor cable in the one we built, but you can vary it according to your needs. Multi-core cable with a circular cross-section is probably the best choice for a permanent installation. If you drill the holes just big enough to feed it through, you can get a fairly tight seal so that dirt and dust can't get in.

Setting the jumpers

Before putting the lid on the box you need to set the three links or jumpers (labelled LK1, LK2 and LK3). If you want to change them later you will have to remove the lid.

Placing a shorting block on LK3 (labelled "OVER") will make the buzzer sound whenever the sensed temperature goes over the upper threshold. The limit can be changed any time, but the jumper can't be changed as easily.

Similarly, LK2 (labelled "UNDER") will, if shorted, cause the buzzer to sound if the sensed temperature is below the lower threshold.

The third link, LK1, is labelled "BACKLIGHT" and not surprisingly, if shorted will enable the LCD backlight. Unless low current consumption is critical this is probably a good idea, since it makes the LCD text more easily visible, especially in dim light.

The majority of applications will not require LK2 and LK3 shorted at the same time, so the kit is supplied with two shorting blocks. If you need more, they are readily available (eg, from old computer motherboards!).

Finishing off

Feed the cables through the holes drilled in the case. Pull them through far enough that you can screw the wire ends into the terminal blocks on the PC board. Make sure that no loose strands of wire emerge from the terminal blocks to short their neighbours.

Once all wires are firmly attached you can snap the PC board into place. This may require pulling the cables partially back through the holes in the case.

You can now remove the protective plastic film from the LCD and place the lid on top of the box, making sure that the push-buttons move freely in their holes. Secure it in place using the four supplied self-tapping screws.

Final set up and use

To adjust the settings, press the "menu" button. The display should now read "MIN TRIGGER" at the top and the bottom line should indicate the current lower temperature threshold. This is the temperature which will trigger Relay 1 in the event the sensed temperature falls below it, and set off the "UNDER" alarm if you have enabled it.

Press the up and down buttons to adjust it – each press will change the value by 0.1°C.

Now press the "menu" button again and the display should show "MAX TRIGGER", which is the temperature which will trigger Relay 2 in the event the sensed temperature rises above it, and set off the "OVER" alarm if you have enabled it. MAX TRIGGER is adjusted in the same way as MIN TRIGGER.

Press the "menu" button a third time the top line will read "HYSTERESIS". This determines how often the device you are controlling with the thermostat will switch, by setting the amount by which the temperature has to change after the thermostat switches, for it to switch again.

For example, if you set the upper threshold temperature to 25°C and the hysteresis value to 0.5°C, then Relay 1 will switch on as soon as the temperature exceeds 25°C, but won't switch off until it falls below 24.5°C. The same is true of the lower threshold but in reverse. This prevents rapid switching of the relay due to the feedback loop formed by your heater/cooler.

A larger hysteresis value will cause the heater/cooler to switch less often, but also means the temperature will vary over a wider range.

Once set, press the "menu" button again and the default display should re-appear.

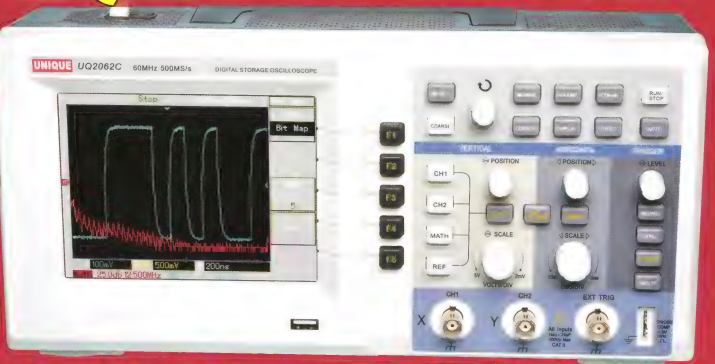
The thermometer/thermostat will operate normally again and the new values, stored permanently in EEPROM memory, will take effect. SC

Where from, how much?

This project was designed and developed by Altronics Distributors Pty Ltd who retain the copyright on the design, the microprocessor code and PC board artwork.

Complete kits (as per the parts list opposite) are available from all Altronics stores, dealers and web store (www.altronics.com.au) for $74.95 including GST (plus P&P if applicable).

UQ2062C DSO:



Not just special, it's UNIQUE!

Review by NICHOLAS VINEN

The UNIQUE UQ2062C is a highly affordable and portable entry-level 60MHz, 500MS/s digital storage oscilloscope with a colour screen and two channels.

It was only a few years ago that a Digital Storage Oscilloscope was an expensive, exotic instrument that few hobbyists could hope to own. Now, DSOs are very affordable, especially for this scope, with a special offer for SILICON CHIP readers. If you quote a special code (see end of review) you can buy this dual channel, 60MHz model with a colour screen for just $695 including GST – about 10% off normal price!

The UNIQUE UQ2062C is an attractive, compact unit. With an integrated carrying handle, it is very similar in size and configuration to many of its more expensive competitors, from companies like Tektronix, Rigol and GW.

The screen is the same size and resolution as most similar products – a 14.5cm (5.7") 320x240 quarter-VGA display. It is bright and quite easy to read, although its blacks are not as dark as we've come to expect. There is a reason for that, as we will find out later.

It is supplied with an IEC power cable, USB cable and two 1.5m 60MHz

1×/10× probes. Each probe comes with an earth alligator clip, compensation adjustment tool and a number of different coloured plastic rings, which make it easier to tell which probe is connected to which channel.

It would be nice if the probes came with more accessories, such as earth spring clips but you certainly get enough to start with.

While there are cheaper DSOs available but they mostly have monochrome displays. In case you're wondering why it's worth spending some extra money to get the colour screen, the primary advantage is that it's obvious at a glance which waveform is from which input channel. This allows for more flexible use of the display.

For example, if you scale both traces to the full height of the screen on a monochrome 'scope, it can be hard to tell which is which – not so when they have distinct colours.

This also applies to the FFT readout and the traces generated from the "math" menu. They can be displayed simultaneously with the raw traces and so have their own colours to avoid confusion.

Usability

The first thing you'll notice switching it on for the first time is how fast it boots. It's under three seconds from turn-on to operation – that's pretty good for a digital scope.

The second impressive aspect is that the screen update rate is excellent. The rapid display refresh makes it feel a lot more fluid than many other low-end DSOs – something that a long time Cathode Ray Oscilloscope user would appreciate. This explains the lower-than-expected contrast, as contrast and refresh rate are a trade-off with Liquid Crystal Displays.

After you have switched it on for the first time, the instruction manual suggests that you manually run the input calibration routine. Once triggered, the procedure is automatic and takes about a minute. This improves the accuracy of measurements by trimming away input offset voltage and scaling errors. Presumably, this procedure should be repeated periodically to keep measurements as accurate as possible.

There is no automatic calibration mode, which can be a minor inconvenience. However, sometimes oscilloscopes that do feature automatic calibration can be quite annoying – they always seem to do it right when you're in the middle of taking a measurement!

The controls and menus are easy to learn. Partly, this is because the UQ2062C has less features than other DSOs.

This may seem like a big disadvantage but in fact, all the most important features are there. There are even some advanced modes included, such as the ability to record continuous waveform data to memory and play it back later. For the most part, the missing features are those which most entry-level users would not miss.

For example, it has Edge, Pulse and Video trigger modes but not Slope, where the trigger is based upon the rate of change of voltage over time. While Slope mode is theoretically useful, it's rarely needed.

This simplicity turns out to make the UQ2062C surprisingly pleasant to use, since it keeps the number of menu options low. When all you want to do is change the trigger source or acquisition mode – something that you'd be doing frequently – not having to dig through a series of menus and options to find the one you need is great.

As a result common tasks involve fewer button presses and knob turns than other digital oscilloscopes we've seen.

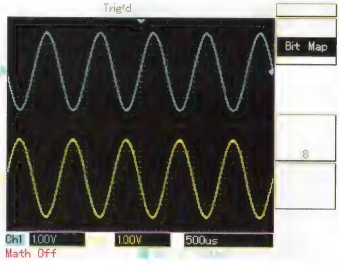
Features

We've come to expect certain features from a DSO and the UQ2062C doesn't disappoint.

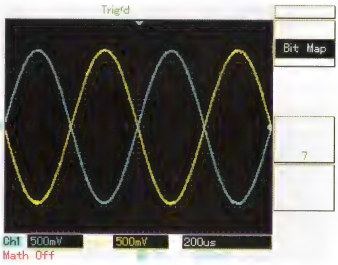
The measurement system is easy to use and all the common measurements you'll want to take are there – including frequency, RMS voltage, peak-to-peak voltage and even channel-to-channel delay.

The "math" menu allows you to add, subtract, multiply and divide readings between the two channels as well as perform Fourier Transforms (FFT). You can use the two channels in XY mode, ie, plot them against each other and there are some advanced trigger modes such as alternate trigger, where each channel is separately synchronised. This slows down the update rate but there are situations where it is useful.

As for the input system itself (a critical feature in an oscilloscope after all) it's quite good.



This shows the display with 1kHz sine waves applied to both inputs, 180 degrees out of phase, after pressing the "auto" button.



The same waves, shown full scale and centred, giving better vertical resolution. Without a colour screen this could be confusing.

Sensitivity goes as low as 2mV/division. If you're using the probes in 10× mode (and for high frequency signal measurements this is a must) then that means it will display 20mV/div which is low enough to show millivolt-level details in the signal.

You want a setting that sensitive for observing low voltage signals in detail, such as switch-mode power supply ripple waveforms.

Noise performance at the 2mV/div level is also very good – in fact there's less noise there than is evident on more expensive competitors.

Another impressive feature of the input system is the 1-million sample memory buffer.

What this means is that you can sample a waveform at high resolution, so that you can see all its details but also retain enough additional samples in memory that you can scroll the window left and right to see what happened before and after the trigger point.

Many other DSOs have much smaller buffers – in some cases a tiny fraction (10k samples or 1% as large), which makes it difficult to get both good time resolution and a long history.

The sample rate is good too, 500 million per second (500MS/s) if you're observing a single channel and 250MS/s when using both. That's more than enough for 60MHz signals.

It has the usual acquisition modes – normal, averaging and peak detect along with a 20MHz bandwidth limiting feature to reduce high frequency noise when you're observing lower frequency signals.

Like most DSOs the UQ2062C has an "auto" button which attempts to set up the triggers and scaling to suit whatever you have connected to the input(s). In general it seems to work quite well, usually saving you some hassle fiddling with the settings.

Storage & external interfacing

There is a USB host port on the front panel into which you can plug a USB flash drive for storing settings, waveform data and screen captures. This is a very handy feature both for computer analysis of captured data and so that you can keep a record of the waveforms you have observed.

It's also handy in case you want to show somebody else what you are seeing on the oscilloscope screen.

Data can also be download directly to a computer using the USB port at the rear and the provided cable, however unless you already have a computer at your workbench the flash drive method is more convenient.

One problem I've found compared to more expensive DSOs is that when you take a screen capture on the UQ2062C, you can't include any of the measurement data with it, because measurements are displayed in the same area of the screen as the storage menu. Keeping the measurements off the main part of the screen does prevent them occluding the traces, so there is a reason for it but being able to see the measurements in a screen capture is very useful.

Another disadvantage of the menu system UNIQUE have come up with is that the menu is permanently visible at the right side of the screen, which limits the display area for the traces. Some other DSOs let you hide the menu when you don't need it so you can use that screen area for waveform display. This is clearly a trade-off they have decided on to make the menu system simpler – but it would still be nice to have a full screen option.

No free lunch

By this stage you're probably starting to wonder what the catch is. As mentioned, this oscilloscope doesn't have every single feature that more expensive models do but it is certainly good enough for most tasks.

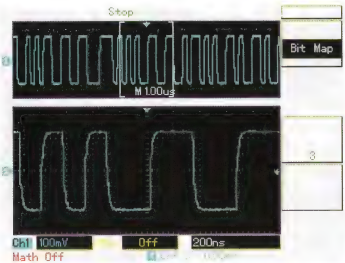
The fit and finish of the unit in general is very good and suggests that it has been designed and assembled with care.

But a discounted lunch!

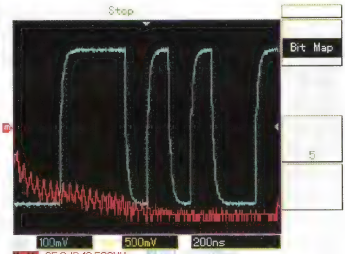
Normal retail price for the UQ2062 is $770 including GST. Until the end of this month, if you quote the special SILICON CHIP reader code of SCUQ2062C to Trio Smartcal (the Australian distributors of Unique 'scopes) you will get almost 10% off, at just $695.

More details?

To take advantage of this offer, or simply to find more information on the Unique UQ2062C DSO, visit the Trio SmartCal website: **www.triosmartcal.com.au**, or call 1300 853 407. SC



Window mode shows the whole waveform as well as some detail. This way you can take full advantage of the 1M sample buffer.



A 3MHz pulse train shown with its FFT frequency spectrum in red. The rounded corners are due to the bandwidth limiting feature.

Vintage Radio

By RODNEY CHAMPNESS, VK3UG

The 1933 Airzone 503 5-Valve Mantel Set

By the early 1930s, some manufacturers were producing quite good superhet radio receivers for the domestic market. The Airzone 503 was designed for the low-cost end of the market but still came in an attractive wooden cabinet and offered good performance.

RADIO RECEIVERS were still very much at a developmental stage in the early 1930s, the very first sets having been built just 30 years earlier, around 1900. During that time, they had developed from modest "breadboard" pieces of equipment through to the "coffin-style" cabinets of the 1920s and then to steel chassis sets from the late 1920s onwards.

A steel chassis made life so much easier when it came to design and manufacture. It meant that each receiver made would consistently perform according to specification, provided of course that the correct components were used and the wiring had been correctly carried out.

Of course, some designs were "dogs" due to poor design and construction but many manufacturers did have

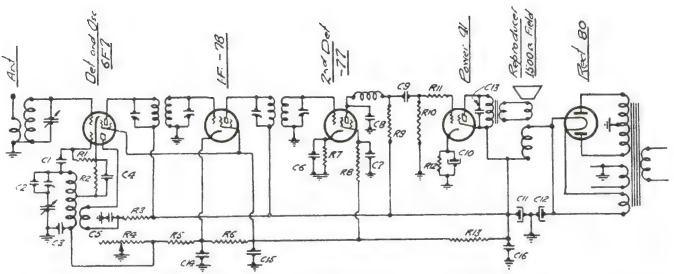


Fig.1: the circuit is an early supherhet design, with the first valve (6F7) acting as a mixer/local oscillator stage. The second stage (78) functions as an IF amplifier, while the 77 functions as an anode bend detector. A type 41 valve is used as the audio output stage, while an 80 is used for the rectifier.

good engineers who designed excellent equipment. Some of that early equipment is still around today and can still turn in a good performance. One such receiver is the Airzone 503, described here.

The Airzone 503

This particular Airzone 503 belongs to a friend and it had been restored several years ago. As a result, there wasn't much I had to do to get it running at peak performance.

As shown in the photos, the set is housed in an attractive medium-sized wooden cabinet. It has a matte finish applied to the timber, which makes it really look the part. However, being built around 1933/4, it only has a rudimentary tuning dial, a feature it shares in common with many other sets of that era.

Basically, the dial consists of a smallish knob with a moulded pointer on it to show what part of the band the set is tuned to. This knob is connected directly to the twin tuning gang and so the tuning is quite direct. However, this isn't really a problem as the IF (intermediate frequency) bandwidth is quite wide.

The volume control is basically a rheostat. It rotates through 330° and uses a knob that's identical to that used for the tuning. However, the controls are reversed to what we normally expect, with the tuning control on the left and the volume at right.

The above-chassis components are well laid out and everything is quite accessible. One unusual feature is the use of a curved metal sheet to form a shield between two of the stages in the receiver. I've never seen anything like that before.

A look at the circuit

Initially, I had problems finding a circuit diagram of this receiver. That was until I got onto the Internet and found a reference to the Airzone 503 that steered me to a publication that I had. A quick check in that publication then turned up the circuit diagram for the old Airzone.

It is just so much easier to service or restore a piece of equipment if the circuit is available. A circuit is also essential for understanding how a set works and for troubleshooting, especially when modifications are necessary.

Fig.1 gives the circuit details of the Airzone 503. As shown, the antenna coil is an air-cored solenoid and has

The old Airzone receiver is housed in an attractive wooden case which has been well restored.

The top of the chassis is well laid out, with all parts easy to access for service. Note the unusual S-shaped metal shield between the IF amplifier (78) and detector (77) stages. A separate shield is also fitted to the mixer/oscillator stage.

no top coupling from primary to secondary. This technique assisted in maintaining reasonably constant performance across the broadcast band.

Sets at that time were designed to work with long-wire antennas, perhaps up to 30 metres long and mounted up to 12 metres high. These large antennas provided such good signals that the deficiencies inherent in early antenna coils were of no great concern. It was only when customers wanted to use their radios on a 6-metre length of wire run around the picture rail inside the home that manufacturers had to design coils to suit these much shorter antenna lengths.

The signal from the first tuned circuit is applied to the signal grid of the pentode section of a 6F7. The triode section acts as the local oscillator and the oscillator signal is cathode-coupled into the pentode so that it acts as a mixer.

By the way, the 6F7 was designed for the frequency conversion task but it was also suitable for use in the types of circuits that used common triode/pentode miniatures (6U8, etc) towards the end of the valve era. The 6F7 was never made in Australia but given its versatility, it probably should have been used more widely.

The signal on the plate of the 6F7 is fed to the first IF (intermediate frequency) transformer which is nominally tuned to 455kHz. Its output is in turn applied to the grid of the remote cut-off IF amplifier which is based on a 78 valve (a 6K7 is an octal equivalent). The output from the 78 is then coupled via a second IF transformer to a 77, which is a sharp cut-off pentode.

Anode bend detector

The 77 is configured as an anode bend detector. The anode bend detector was common in the early to mid 1930s, as few valves were made that combined an RF pentode with detector and AGC diodes in the same envelope. For the time, they provided effective detection of the RF signal and reasonable amplification.

In operation, the 77 is biased near cut-off, so that only the positive going sections of the RF signal are amplified. The valve operates very much like a single-ended class B stage and as such there is distortion in the output. This is one of the main deficiencies of this type of detector.

The other deficiency is that the signal level needs to be kept within a relatively small range (the "sweet spot") so that the distortion is minimised. In this receiver, Airzone appear to have got it right, as the signal level applied to the detector results in good audio levels at the set's output. In fact, the circuit used here is similar to that used in many other receivers with anode bend detectors.

The detected RF signal appears on the plate of the 77 and is filtered to recover the audio signal which is then applied to the grid of a 41 output valve. The filter circuit is formed by capacitor C8 and the following RF choke in the plate circuit of the 77. In addition, resistor R11 acts in conjunction with the grid to cathode capacitance of the 41 to provide additional filtering.

The resulting audio signal is amplified by the 41 and applied to a 5-inch (125mm) electrodynamic loudspeaker.

Note that it's important to keep RF signals out of the audio output stage. If this is not done, they will be amplified and radiated back into the IF amplifier, causing RF instability.

Power supply

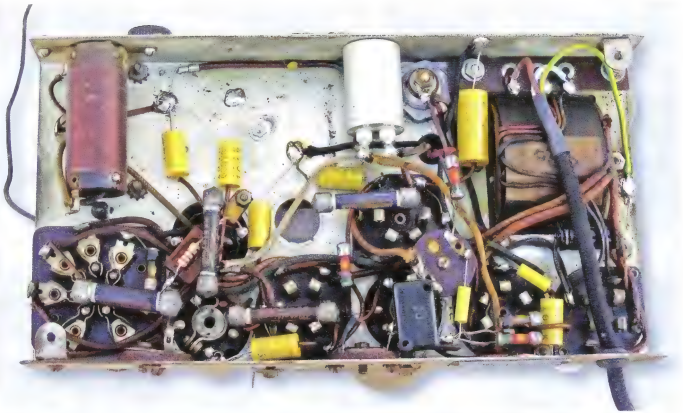
The power supply is quite conventional and uses a mains transformer to drive an 80 rectifier stage. The 80's HT output is then filtered using two 8μF electrolytic capacitors and the field coil of the electrodynamic loudspeaker.

Note that although the circuit doesn't show it, the primary of the mains transformer has two tappings – one for a 200-230V input (colour coded black & yellow) and the other for 230-250V (colour coded black & red). As with virtually all receivers of the era, there is no mains on-off switch which means that the unit has to be switched on and off at the power point.

No AGC

This set, like many from the early 1930s, does not have automatic gain control (AGC) to compensate for signal strength variations between stations by automatically adjusting the volume. This means that, depending on signal strength, the volume can vary from one station to the next and so has to be manually adjusted each time a station is tuned.

The volume control itself takes the form of a 4kΩ rheostat (R4), which forms the earthy end of a voltage divid-



All the original paper capacitors under the chassis had been replaced, as had the electrolytic capacitors and the mains power cord. The mains cord had not been securely anchored, however.

er from the HT line. When the moving arm is set to the R5 end (see Fig.1), the RF amplification is at maximum (and so is the distortion on strong stations). Conversely, when the control is set to the far left, the two front-end valves are cut off and there is no audio output.

Note that both the 6F7 and the 78 require quite a high negative voltage to cut them off (about -40V). When their cathodes are at about 40V positive with respect to the chassis, their signal grids are at chassis potential, ie, the grids are at -40V with respect to the cathodes.

Restoration

As indicated earlier, I had nothing to do with the restoration of this set. The owner obtained it in a fully restored condition and it had been very well done, which regrettably often isn't the case. In fact, sets are often advertised as being fully restored only for the new owner to later discover that the restoration is often not much more than a figment of the seller's imagination.

In this case, the cabinet was in excellent condition but not being an expert on cabinet restoration, I cannot definitely say what the finish is. It has a matte appearance and I suspect that some form of oil has been used to obtain what is a very impressive result.

Out of curiosity, I decided to remove the chassis from the cabinet. This involves removing the two knobs and the two chassis retaining screws underneath. However, as I started to slide the chassis out, I noticed that the volume control was not coming with it.

Closer examination revealed that the control was firmly attached to the cabinet by a nut and its terminals connected to the circuit by two flying leads. Undoing the nut freed it, after which the entire assembly (including the loudspeaker) could be removed.

Once the chassis was out, I took a look inside the cabinet and found a metal gauze and what looks like an asbestos pad lining the underside of the top. One edge of this pad had split open but nothing appeared to have come loose. Despite that, I suggested to the owner that it would be wise to seal this pad as asbestos is a carcinogen.

Asbestos sheets were used in quite a few receivers during the 1930s and 1940s to keep heat away from cabinet tops. Heat often spoiled the cabinet finish in early sets, particularly above the output valves and rectifiers.

All the tuning adjustments had been sealed with a dab of yellow paint. The S-shaped shield used on the top of the chassis is unusual but effective in shielding the various sections from each other.

A glance underneath the chassis revealed that the paper capacitors had all been replaced, along with the electrolytic capacitors and the mains power lead. The power lead installation did not meet present-day standards, however. As a result, I spent a few minutes fitting a cordgrip grommet to ensure that it was anchored correctly.

I didn't have the circuit diagram at that stage and so I wasn't quite sure what valves I would find in the various sockets. As a result, I looked at each of these in turn and they were all familiar types except for the output valve which was an NU41. However, I could find no reference to it in my valve manuals.

Eventually though, I found a small sticker which indicated that the valve was a type 41, which I did know. So an NU41 is in reality a 41.

Trying it out

Everything looked to be in good order, so I connected the set to an antenna and applied power. The result

Photo Gallery: Diason Model 32/6

The Diason Model 32/6 was manufactured by a small company and used the following valve line-up: 3 x 6SK7, X61M, 6SQ7 and 25L6. If these valves seem unusual, it's because the sets came in three models which were designed for operation on DC supplies of 32, 50 or 110V respectively. The six valves (or seven in the push-pull audio output model) were all RF and audio types, as a rectifier was not needed. Photo by Kevin Poulter for the Historical Radio Society of Australia (HRSA). Phone (03) 9539 1117. **www.hrsa.net.au**

was a complete anti-climax because I got absolutely nothing from it.

This was not looking good, as tracking down and fixing the problem without a circuit diagram could take some time. Nevertheless, I began by checking the voltages on the various valve elements and all but the cathode voltage of the 6F7 were close to what I would have expected. That was a worry, as 6F7s can be difficult to obtain.

Next, I checked that all the valves were correctly seated in their respective sockets and this revealed that the 6F7 was loose. As a result, I removed the valve and closed up the socket connections using a pair of pliers from the underside of the chassis. I then gave the connections a squirt of Inox contact cleaner and re-inserted the valve.

This time, when power was applied, the set began working. Shortly after that, I found the circuit diagram and other general information on the set. This showed that the voltage measurements now all closely matched the specifications.

How it performs

I was pleasantly surprised as to how well this 1930s radio performs. It received all my local stations at good volume and despite having a direct-drive dial system, was easy to tune (aided, no doubt, by the wide IF passband). And despite the likelihood of noticeable distortion being produced by the anode bend detector, the audio output was quite pleasant to listen to.

I checked the tuning range and found that the set covered the frequency range from 550-1700kHz. However, by slightly adjusting the trimmer in the oscillator circuit, this was changed to 530-1630kHz which covers all the stations in my area.

I also checked the IF centre frequency and found that it was up around 480kHz instead of the specified 455kHz. However, despite being 25kHz more than the designated IF, this did not cause any problems.

Some restorers erroneously believe that if the IF is supposed to be 455kHz (or some other frequency), then the IF amplifier must be aligned to that centre frequency or problems will arise with the set's performance. This might be true for some specialised receivers but for the average domestic receiver, a variation of ±5% from the specified frequency is unlikely to cause problems.

In summary, Airzone may not have been one of the large manufacturers but they did produce some very good receivers. The Airzone 503 is a very impressive receiver, especially considering its age. It has been well-restored, works well and is a set well worth having in a collection. **SC**

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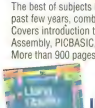

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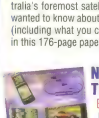

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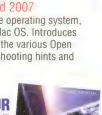

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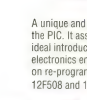

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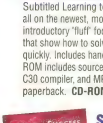

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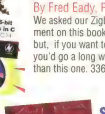

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Playback glitch on message recorder

We have purchased and built the Enhanced 45-Second Voice Recorder Module described in SILICON CHIP, December 2007. It works fine with the exception of one small but quite problematic glitch. When we record a message (we use tape mode for one full-length message) and we try to play it back, the Play function will not start until we have removed the 12V power to the unit for about 10-15 seconds. Then it plays back perfectly.

This happens each time you try to play the message back, by pressing the M1 message playback key.

We have looked at everything carefully but can not see why this is happening other than a capacitor is holding something at a certain potential that prevents the playback starting. When you remove the power to the unit, the capacitor will discharge and playback work again.

Do you have any suggestions as to how to fix this issue? We need to be able to continuously play the recorded message and since there is no loop function in the design, we need to trigger the playback M1 button each time the message has finished.

A loop or repeat function would be even better but we have now built a circuit to activate the playback button automatically. With the current issue unresolved, this won't work of course. (J. D., via email).

● The manufacturer's data on the HK828 voice recorder chip is a little ambiguous with regard to its operation in single message or "tape mode" and the chip does seem to behave differently in this mode (ie, when LK2 and LK3 are both in, pulling down both pins 24 & 25 to ground).

Basically, in this mode, the chip seems to have a choice of "normal" and "auto rewind" options, selected by either pulling pin 9 (M8 Enable-bar) high or low. But the data sheet is ambiguous regarding which is which, ie, whether pulling pin 9 high (as it is in our circuit) or pulling it down to ground instead gives auto-rewind operation.

We suggest that you try pulling pin 9 down to ground, to see if this will achieve auto-rewind operation (which should allow replay of the recorded message each time pin 1 is pulled briefly to ground).

By the way, according to the chip data, when it is operating in tape mode and with the auto-rewind option set correctly, it will loop around and play the message over and over if the M1-bar line (pin 1) is held down to ground. However there is a small pause of 1530ms of silence between the end of one replay and the beginning of the next.

CHAMP is the answer

Have you ever produced a PC board for what the Americans seem to call a "Chip Amp"? They are often built around a National semiconductor unit I think; small and cheap but seemingly very effective. I am not sure what the Australian equivalent is. (R. R., via email).

● In our February 1994 issue, we described the CHAMP, a single chip audio amplifier based on the National Semiconductor LM386. It is a very popular project and is available as a kit from Altronics and Jaycar.

Modifications wanted for 12V charger circuit

I am writing about a Circuit Notebook item in the August 2008 issue on page 57: Charging Controller For 12V SLA Batteries. I am interested in trying this circuit but I'm rather awed by the size of the heatsink you suggest. This may be necessary for a very large battery but I'm only interested in using something in the order of 1.3Ah; certainly no more than 2Ah.

Could this circuit be modified for a 6V SLA battery? I have a couple of garden tools which use 6V SLA batteries and it would be great to be able to hit a switch and change to 6V charging. (B. C., via email).

● If you will only be using the SLA

Positive Line Switching With The Speed Controller

I recently bought a 10A/12-24V DC Motor Speed Controller (SILICON CHIP, June 1997) to run a wiper motor for a car. The car was changed from 6V to 12V and needed a suitable speed controller.

The problem is that the kit pulses on the negative line and not the positive. I cannot control the negative side of the motor as it is earthed through the body of the car.

I have been told that the control unit can be modified to pulse through the positive. Would you please be able to tell me how this is done? (P. V., via email).

● For positive line switching, the two Mosfets would need to be changed to P-channel types. A readily available P-channel Mosfet is the IRF9540N which has a rating of 100V and 23A (Jaycar ZT-2467). Possibly two of these in parallel would be suitable for a wiper motor.

They connect with the gates to the same 4.7Ω resistors in the circuit but the source (S) connects to the +12V supply (cathode of D1) and the drain (D) drives the positive side of the motor with the motor negative to ground.

Remove the 18kΩ resistor connecting to the original Drain of Q1 and Q2. The 7812 regulator should be removed and a wire link placed between the IN and OUT terminals. Note also that the control operation will work in reverse, with full speed at the minimum anticlockwise setting for VR1 and vice versa.

Charging Controller circuit with small (less than 2Ah) batteries, you would probably be able to get away with using a smaller heatsink on the switching Mosfet. You might try using one of the Jaycar HH-8570 heatsinks or even one of their HH-8520 units.

It would probably be possible to modify the circuit for use with 6V SLA batteries. We haven't tried this but the modifications would involve the following:

First, you will need an extra 2-pole double-throw (DPDT) switch. Use one switch pole to connect a 3.6V zener diode across the existing ZD2 & ZD3 combination. This will reduce the reference voltage at pin 3 of the comparator to 3.6V.

Next, add a second voltage divider (2.2kΩ + 5kΩ trimpot + 2.2kΩ) to the circuit between the positive and negative rails and use the second pole of the switch to switch pin 2 of the comparator between the wiper of the original trimpot (VR1) in the 12V SLA position and the wiper of the added trimpot in the 6V SLA position. This will allow you to set the switch-off voltage level for 6V SLA batteries independently of the setting for 12V SLAs.

Battery capacity meter has blank display

I have recently constructed the Battery Capacity Meter (SILICON CHIP, June 2009) using an Altronics kit. I wish to use it to monitor the 12V battery bank in our (non-mains) solar power supply system. I purchased a second shunt resistor and have bolted this in parallel with the first as there is a possibility that the drain current could exceed 80A.

I mounted the unit near the battery bank and was about to start the set-up/calibration procedure. I connected the ground terminal to the battery negative, then connected 12V to the battery positive terminal. When I pressed the pushbutton (S1) there was a short beep from the beeper and the display backlight lit for a second or two. The display was blank.

The voltage between pins 1 and 2 (GND) of CON4 was between 4.99V and 5.00V and the voltages at pins 5 & 6 were around 13V (the Sun was out and the batteries were charging).

I disconnected, removed the board and rechecked my solder joints with a good light and a strong magnifying glass. I also rechecked the orientation of diodes, transistors and electrolytics and checked that there was continuity between pins that should have been connected between IC1, the display, the keypad ground and +5V.

I found the directions a little lacking between the end of construction and the start of calibration. The check of the 5V supply was fine, then nothing was said about what should (or should not) be connected prior to calibration.

I suppose it was obvious that a voltage was needed between ground and Batt+ but I was a little hesitant about connecting a large-diameter, large-current cable to the shunt resistor until I had some idea of whether the unit was operating correctly (or operating at all!).

Can you give me any clues as to why the display is blank? What should it be showing when power is first connected? Do I need to press button S1 after first connecting power, to start the unit operating? (D. R., via email).

- If you are not comfortable with connecting a battery to the unit for testing, you can power it using the USB port. Connect it to your PC using a USB cable (with no battery connected) and it should turn on without having to press S1.

S1 only needs to be pressed to turn the unit on when it is powered by a battery. Normally, when you turn the unit on by pressing S1, there should be a short beep, then the backlight should come on and the display should read something like "Battery Capacity Meter Version 7.30".

The reason you are not seeing a display could be because:
(a) the LCD contrast set by trimpot VR1 is incorrect – try adjusting this with a screwdriver.

Digital Audio Player Has Hardware Limitations

I have to say I was impressed with the article on the Digital Audio Recorder/Player (SILICON CHIP, August 2009) at first; it really was what I was looking for. However, after reading the article in more detail, I have been completely deflated by the file support or rather, the lack of support.

I don't mind missing out on MP3 files but I assumed that it played WMV files (I inadvertently didn't notice the difference: WAV versus WMV). WMV files are much more compact (like MP3 files) and therefore this device won't really do what I want. I have already ripped my entire 200+ CD collection to my computer in anticipation of something like this turning up from someone and it comes to just over 13GB in WMV or MP3 format.

I was hoping that your new player would take these files but alas no. Is there any chance that the firmware could be updated to play WMV files or MP3 for that matter (although I am not fussy either way)?

If the decoding cannot be done on-board, could an after market add-on board such as the one from Futurlec be wired into this one, with a firmware update to the main chip? Or perhaps you could use an STA013 chip (also available from Futurlec for less than $10) on a small add-on board? (A. S., via email).

- For hardware reasons, the music player/recorder does not play compressed formats, only WAV files. This is because the microcontroller used is simply not fast enough to play compressed audio formats like MP3 in real time. It was primarily designed as a voice recorder and it was never intended to be a general music player.

Yes, we could add a hardware MP3 decoder but that would be a different project altogether. Nor could the firmware be easily adapted to play MP3 files with a hardware decoder like the STA013 – the design was simply not conceived with this in mind.

In any case, the proper way to design a general music player would be to use a powerful DSP engine whose firmware could be updated to play different formats like MP3, Ogg Vorbis, etc. There are licencing issues with MP3, for example, that would make such a project not feasible for a magazine like SILICON CHIP. Moreover, such powerful DSP engines are only available in surface-mount packages like TQFP (thin quad flat pack) which would be difficult for hobbyists to install.

LED Lights For A Chevrolet Truck

I am trying to repair a 1954 Chevrolet truck. It has a 6V power system and generator. The lights are all wrecked and I have tried to obtain modern replacements but the local auto shops say there are no suitable 6V lamps available. I examined several LED lights, thinking these would probably work on 6V but they all specified from about 8V to 30V. I even tried one on a 6V battery but there was no light output at all.

I would like to use the LED lights if possible due to smaller current requirements and therefore less voltage drop to the back of the tray of the truck. The truck has been equipped with a flasher unit in the past and I have a couple of 6V globes which I could use in the front because I believe that the flasher needs a load to make it operate.

I am contemplating installing as many white LEDs as will fit in one of the new lights and using a voltage regulator, say 5V, to run the LEDs. Would it be necessary to add a limiting resistor to each LED or could I calculate the current for the total number of LEDs in each bank and use one resistor to control them all?

On another subject, I wish to control a windscreen wiper motor so that it will go forwards or backwards. I seem to remember (from many years ago) a circuit with four transistors which would do this job. I think it might be called an H-circuit and I seem to remember a design for a cruise control which used such a circuit to control a windscreen wiper motor. (R. B., via email).

● The 12V LED lamp replacements probably have two LEDs in series for white LEDs (with a 3.5V drop across each LED) and possibly three LEDs in series for red (2.2V drop) and orange. This means that they will not work on a 6V supply, as the required voltage drop across the series LEDs is above 6V.

For lighting on 6V, you would use just one white LED with each resistor or two red LEDs. LED current is calculated as the (supply voltage minus the LED voltage drop) divided by the resistor value. Alternatively, the resistor value can be calculated as the (supply voltage minus the LED voltage drop) divided by the LED current.

Typically, LEDs can be run at 20mA with a margin of safety when the specifications state a maximum of 30mA. This means a white LED should use a resistor value of (5V-3.5V)/20mA = 75Ω for a 5V supply. The resistor power dissipation is calculated as the current squared x the resistor value. In this case the power dissipation is .03W and so a standard 0.25W resistor can be used.

A transistor H-drive would have to have a 10A or more current rating for a windscreen wiper motor. A 6A-rated H-drive circuit driven from 5V is used in the Railpower Mk.4 described in September 2008. When the RB1 line from IC1 is at +5V and the RB2 line is at 0V, the H-drive drives the motor in one direction. With RB2 high at +5V and RB1 low at 0V, the motor is reversed.

Instead of using the microcontroller, a single-pole double-throw switch (SPDT) could be used to control these lines. Connect the common of the switch to +5V and the other terminals to pins 13 and 9 of NAND gates IC2d & IC2c. This assumes that the microcontroller is out of circuit. The NAND gate inputs are tied to 0V normally using 100kΩ pull-down resistors.

Note that the transistors may need a higher current rating to control a wiper motor.

Alternatively, a 10A double pole double throw (DPDT) switch could be used. Connect the two common terminals (centre terminal) of the switch to either side of the motor. The NO (Normally Open) contact for one pole connects to 0V and the NC (Normally Closed) contact for the same pole connects to the 6V. For the other switch pole, the NO connects to 6V and the NC to 0V.

(b) any one of diodes D3-D6 is incorrectly oriented;
(c) there is a connection problem with one of the lines going to the LCD module. You should check the continuity between pins 25, 26, 27, 28, 11 & 12 of IC1 and the LCD module – refer to the schematic on page 22 of the June 2009 issue of Silicon Chip.

Power supply for the DAC

I'd like to ask a question about the recently published "High-Quality Stereo Digital-To-Analog Converter" project. I understand that this uses the same power supply as your October 2005 preamplifier.

Would this power supply be capable of driving both the DAC modules and the headphone amplifier module of the preamplifier? I am thinking of building these two modules into a single case, and so it would be convenient if they could share a single power supply. (J. B., Umina Beach, NSW).

● The answer is probably yes. The transformer should be OK but it will probably be necessary to use a bigger heatsink for the 5V regulator and to fit heatsinks to the 15V regulators.

Driveway Sentry has a problem

I built and have been using the Driveway Sentry on my property for a few years and it has worked quite well until now. A few days ago, I removed the link on the circuit board to stop the on-board piezo from sounding when the unit was triggered. It worked for a few more days and now has stopped working completely.

I am assuming removing the link has nothing to do with the fault. Everything seems to be OK and I can trigger the unit using the test button but the unit does not trigger when a car passes.

I am suspicious that the coil has gone faulty, as I get around 10MΩ between the two wires. I also get around 500kΩ between each wire and the ground. What are the expected resistance measurements of the coil? Is it possible to buy a replacement coil? I would guess fixing the coil would be out of the question. (C. B., via email).

● If you get a resistance reading of around 10MΩ between the two wires to the sensor coil, this certainly suggests that the coil has gone open

circuit. Normally, you should get a reading of about 300Ω. Either that, or an open circuit has developed in the cable to it or in one of the cable-coil connections.

We suggest that you contact Jaycar's kit department to see if you can get a replacement coil.

Running problems with the Railpower

I have built an Altronics kit of your Railpower Mk.4 (SILICON CHIP, September & October 2008) and it doesn't work properly.

On power-up, it appeared to be OK. The front panel works OK in that all the buttons work in their various modes but the speed has zero in both positions and cannot be adjusted.

At power up, the LCD shows a full bargraph upper & lower, a direction arrow, "S" and 100 percent. All the buttons appear to work OK according to the October 2008 issue but there is no output and the speed control does nothing. Do you think that the PIC micro is faulty? D. G., Maldon, Vic.

● From your description, your Railpower appears to be in the set mode where the settings are adjusted. Try changing from Set to Run with the S1 switch.

Alternatively, switch S1 may be installed 90° to its correct orientation. For speed control, check that the local setting for VR1 does work. The PIC does not appear to be faulty as it shows correct operation for the LCD module.

Speedo corrector signal range query

From what I can understand of this kit, the Speedo Corrector (SILICON CHIP, December 2006) is designed to operated from speedo signals based on either 5V or 8.2V. I have a 1993 Range Rover with electronic speedo. It would appear that the speedo signal is pulsing between 0V and 12V.

I have gone through the set-up process but I cannot get it to recognise the speedo signal. Will this kit work on my vehicle? If not, are there any changes I can make to get it to work? (I. M., via email).

● If the speedometer requires a 12V signal then the LK1 connection can be made to the nominal +12V at the cathode of ZD1. This will provide a 12V output swing as well. The Corrector should automatically detect the speedometer signal after selecting the pull-up, pull-down or AC input.

If not, check the value of the pull-up or pull-down resistor used in the speedometer sensor of your car. The pull-up/pull-down resistors at the input of the Speedo Corrector may need to have the same value. These resistors are currently 1kΩ, at the collectors of Q4 and Q2.

Ignition Problems With An Old Ducati

I need some assistance with the Programmable Ignition System Mk.2 and its associated Coil Driver (SILICON CHIP, March, April & May 2007).

Our problem is with a 1974 Ducati 450 Desmo single-cylinder motorcycle which was originally fitted with Ducati's own stand-alone electronic ignition system. This consisted of a source coil, triggering reluctor and combined coil/ignition unit.

After a complete mechanical rebuild we were unable to start the engine. We established that there was no spark. We also established that the source coil and reluctor were functioning but not strongly. We deduced that the coil assembly was faulty; not unreasonable for 30-year-old Italian electrics.

We then purchased the CDI module for motorcycles (SILICON CHIP, May 2008). This, in conjunction with a 12V coil, produced a spark but nothing outstanding; rather feeble, in fact, for a high-compression engine. However, it must be admitted that the input voltage and trigger voltage were well below the figures given in the kit's test procedure and those given to us by a Ducati expert. That said, it did spark and the reluctor did trigger consistently at the correct time as checked with a Xenon light.

We believe that the sparks were not able to overcome the engine's compression pressure. We also believe that a possible cause is loss of magnetic energy in the magneto flywheel. These, I am told, cannot be re-magnetised.

Our next move was to abandon the stand-alone system and go to a 12V battery system, and so we purchased the Programmable Ignition System, in the belief that it would do the business. After reading the "blurb" which was not available before purchase, we suspect this system may be far too complex for our needs.

The Ducati is really a simple 1-cylinder, 4-stroke unit and up until 1973 made do with a 6V coil and points set-up with centrifugal advance. By the way, their electronic trigger is a bipolar affair which apparently provides the advance curve required by this engine as the speed rises. So, can we "dumb down" this system we have bought?

Can we adapt the Programmable Ignition unit to run this engine and if so, do we need to acquire the LCD Hand Controller to do this? How would we map the advance curve of this engine anyway, as we cannot start it? Or does the Programmable Ignition have a default setting which allows the engine to start and will this system respond to the Ducati reluctor?

Or could we combine some or all of these units with the CDI unit to amplify the source energy and boost the spark at the plug? (K. T., Mt. Hawthorn, Vic).

● The CDI unit probably does not work because the high-voltage generator coil in the Ducati may have a shorted turn. We are not convinced that the magnets have been demagnetised. You cannot mix the CDI unit and the programmable ignition.

The Hand Controller would be required for the Programmable Ignition to make the necessary adjustments. You need to set the number of cylinders and other parameters with this Hand Controller. The default ignition advance is zero and so you would be able to start the engine where initial timing is set by the trigger.

The Programmable Ignition will operate from the Ducati reluctor.

Batteries for old transistor radios

I have a Kriesler "trans-mantel" (as featured in your June 2006 issue). It belonged to my father and as far as I

Notes & Errata

PICAXE-controlled watering system, February 2010: the suppression capacitor across the motor should be increased from 10nF to 220nF.

know would be in working order but I have no idea as to where to locate a battery for it. Are you able to help with info? (V. B., via email).

● Batteries for all those old transistor portables are no longer made and are simply unobtainable. However, it is possible to make up a battery pack using 1.5V C-size cells. Alternatively, fit a suitable DC socket on the rear of the case and power it from a regulated 9V DC plugpack.

Bike CDI runs out of puff

I built the Replacement CDI Module (SILICON CHIP, May 2008) for my Yamaha 350cc twin-cylinder 2-stroke motorbike. It runs fine up to a point.

I took the bike out for a spin and it seems to rev to just under the power band. It revs better with one capacitor and removing the thermistor made no difference.

I figure it like this: at 6000 RPM, it's pulsing twice per revolution, so effectively it's pulsing at 12,000 RPM. I suppose this is OK for a go-kart motor but the bike motor revs to 9000 RPM, so it has to pulse effectively up to 18,000 RPM.

I tried a different capacitor and it was worse so I think a faster-charging capacitor will work better. Any ideas? (D. W., Krugersdorp, South Africa).

● The ability to run up to 9000 RPM with full spark is dependent mostly on the high-voltage generator coil in the bike to charge the capacitor up in time. You could try using a smaller charge capacitor that will charge faster.

Alternatively, the high-voltage generator coil on the bike might have a shorted turn which would prevent full charging of the CDI capacitor in the available time at 9000 RPM.

Signal strength meter for Jupiter receiver

I built the Jupiter Receiver (SILICON CHIP, August 2008) and would like to fit an analog signal meter to the unit. Where should it be installed – before the volume control or should I perhaps sample the signal at pin 1 of op amp IC2a? (C. J., Dandenong, Vic).

● We suggest you use a fairly sensitive meter, ie, 50μA FSD, and connect it between pin 1 of IC2a and PC board ground, with a suitable series resistor to make it effectively read 0-6V.

For example, if you use a 50μA/3kΩ meter movement, the series resistance should be 120kΩ - 3kΩ, or 117kΩ (although it would be OK to use a 120kΩ resistor).

Caravan charger/ booster wanted

I have a newish caravan which has an on-board 12V battery which supplies all the lighting, water pump, TV & radio etc. This is fine as long as you are always on a powered site, as the inbuilt 240V to 14V battery-charger/ power-supply supplies all the 12V items in the van and keeps the battery charged.

For cost reasons, we often use an unpowered site as the inbuilt battery can supply the lighting etc and we use gas for the stove and fridge. Whilst we are travelling, the car generator supplies the van load which is 13.5A, for the fridge. The voltage at the van is then about 12.5V; too little to charge the van battery. The cable to the van is rated at 30A and is protected by a 30A thermal circuit breaker but even so the voltage drop is about 1.7V.

I understand this is a common problem and I have seen some hairy schemes for curing it. One suggested rewiring the generator circuit! I have located a gadget which solves the problem. It is put out by GSL Electronics (**gsl.com.au**) and I was told that this device can supply 25A output down to 9.5V input.

For me this is serious overkill. To replace the charge taken by a few days' battery usage would need only a few amps (eg, 5-6A for 6-8 hours) as I replaced all the incandescent and fluorescent lights with 0.5W LEDs. The real killer though is the asking price: $528!

This gadget is obviously aimed at professional markets and does too much at too high a price for a normal caravanner. Has SILICON CHIP ever designed such a circuit or do you think you might in the future ? Alternatively do you have any suggestions? (N. R., via email).

● The simple but crude answer is to use a 12V to 230VAC inverter to run the caravan battery's charger while you are on the move. A more elegant answer would be to have a step-up battery charger which runs from the car battery. We have not yet produced a circuit along these lines but one is planned for publication within the next six months or so. SC

WARNING!

SILICON CHIP magazine regularly describes projects which employ a mains power supply or produce high voltage. All such projects should be considered dangerous or even lethal if not used safely.

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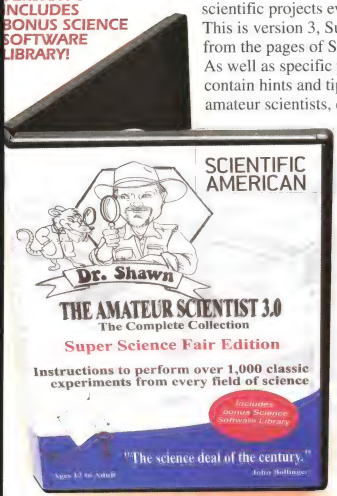

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Book Review – continued from page 69

Throughout the book, there are several complete amplifier schematics presented which have been the basis of many a great hifi amplifier. There are also many different circuit fragments shown which give hundreds of different possibilities for a complete design. This provides ample room for experimentation, if you are so inclined. It should be noted that all the schematics presented are very well laid out and easy to understand.

This is not really a book for beginners but neither does it require readers to be experts on the subject. What you need to get the most out of it is a good understanding of the generic Class AB amplifier and an intuitive grasp of the way basic components function.

Readers should understand bipolar transistors well, as well as diodes, resistors and capacitors. With that in mind, it will guide you from basic competence to an expert level understanding of the inner workings of power amplifiers.

If I have one doubt, it is with the Author's criticisms regarding the use of Mosfets as output devices.

While the criticisms are for the most part valid, he doesn't make it clear which problems are specific to lateral Mosfets and which are relevant for vertical (switching) Mosfets. Obviously, he has tested both, as examples of both types are mentioned in the chapter, but the disadvantages are lumped together.

For example, he complains that it takes a higher voltage to turn a Mosfet on than a bipolar transistor. That is true but primarily so for vertical Mosfets.

On the other hand, he points out that Mosfets have a high channel resistance but this is really only true for the lateral types.

It is important to note that while this book touches on virtually every aspect of amplifier circuit design, it does not really discuss component layout or track routing on PC boards or chassis component placement.

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In conclusion, this book is a gold mine for analog designers. In fact, the principles described within have broader applications than just power amplifiers.

It contains in a single volume the results of decades of research and will bestow interested readers with a profound knowledge of amplifier design that could only be related by someone with Douglas Self's vast experience in the subject.

You can't learn everything that you need to know about amplifier design from this book but it is virtually required reading for the aspiring designer.

The book is available from the SILICON CHIP bookshop. **SC**

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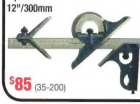

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